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# USSR Report

ENGINEERING AND EQUIPMENT

No. 64



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4 February 1980

# USSR REPORT

## ENGINEERING AND EQUIPMENT

No. 64

This serial publication contains articles, abstracts of articles and news items from USSR scientific and technical journals on the specific subjects reflected in the table of contents.

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## CONSTRUCTION

### NEW ROAD-BUILDING MACHINERY

Vil'nyus SOVETSKAYA LITVA in Russian 28 Sep 79 p 3

[Article: "'Heavy' Vacuum"]

[Text] A proposal by the scientists of Leningrad Polytechnical Institute imeni M.I. Kalinin has allowed the weight of a road roller to be doubled without any additional inputs of metal. A metallic vacuum chamber is placed between the drums of the unit assembly. When the air is pumped out of it, the pressure differential between the atmospheric and "chamber" pressures begins to press the chamber and the entire unit against the ground, thereby increasing the unit's weight.

"In order to produce a compact and good-quality road surface, heated asphalt is ordinarily dragged by a roller weighing from 3 to 5 metric tons," states Professor N. Kharkhuta, director of the research group.

"Then it is replaced by a somewhat heavier unit, and finally, the operation is completed by a drag weighing about 12 metric tons. These three machines will be successfully replaced by one roller, equipped with the so-called pneumatic ballast apparatus."

The advantages are obvious: in making each unit as much as 10 metric tons of metal will be saved, while only a simple vacuum apparatus and an ordinary compressor are installed as additions to the regularly produced machine.

An experimental model of this unique roller, produced by the Stroydormash Kaliningrad Plant, has successfully passed a test of Leningrad's main roads. [431-2384]

2384

CSO: 1861

## CONSTRUCTION

### WINTERTIME ROADBUILDING IN THE FAR NORTH

Moscow IZVESTIYA in Russian 1 Nov 79 p 1

[Article by M. Shimanskiy, IZVESTIYA Correspondent: "Roads Are Being Built with the Help of the Cold"]

[Text] In the Far North roads are necessary in winter, spring, summer, and autumn; moreover, they must be such that do not depend on the caprices of nature. It is not simple, however, to lay a reliable route through tundra and swamps. You need stone and crushed rock. You need a great deal of time. And, in point of fact, it is impossible to utilize equipment in doing this.

What then is the solution? It turns out that in building roads in the Far North we can combat the marshes with the help of....the cold. The design of special pipes has been developed at the low-temperature laboratory of the Institute of Heat- and Mass-Exchange of the republic's Academy of Sciences, working in conjunction Glavsibtruboprovodstroy [Main Administration for the Construction of Pipelines in the Rayons of Siberia and the Far North] and the NIPIESU of "Neftegazstroy."

With their help we can freeze the soil. This installation converts a boggy quagmire into a firm, icy platform, capable of standing up under the heaviest equipment even during the days of summer.

The results of research conducted by scientists have shown the following: during the winter one installation can freeze an icy, underground foundation which will hold up in the marsh for from 4 to 5 years. Six experimental models of the installation have now been created. They are being tested in the Far North and in Tyumenskaya Oblast.

[457-2384]

2384

CSO: 1861

## INDUSTRIAL TECHNOLOGY

### NEW COMPUTER USED TO STUDY EARTH'S DEPTHS

Moscow SOTSIALISTICHEKSYA INDUSTRIYA in Russian Oct 75 p 4

[TASS Article: "Computer Studies the Earth"]

[Text] In the space of an hour geological scientists will be able to "penetrate" hundreds of kilometers into the depths of the Earth's mantle. They will be aided in this by the "Zemlya" automated system of geophysical research which has been developed at the Institute of Geochemistry and Geophysics of the BSSR Academy of Sciences. After receiving extensive information from its field sensors, the computer within a few moments of computation furnishes detailed data on the structure and composition of the interior depths. Just a short while ago this used to take months of collective labor.

The Commission of the Academy of Sciences of the Socialist Countries on Planetary Geophysics has recommended this innovation by the Belorussian scientists for utilization in the CEMA countries.

[431-2384]

2384

CSO: 1861

## INDUSTRIAL TECHNOLOGY

### NEW MAGNETIC PUMP SUCCESSFULLY TESTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian Oct 79 p 4

[Article by L. Radzinskiy, Sverdlovsk: "A Magnetic Field Does the Pumping"]

[Text] They were almost equal in size--the small pump and the rather thick textbook on electrical engineering. And it was certainly not by chance that they lay side by side on a table in a laboratory working on magnetohydrodynamic converters.

"The fact of the matter is," smilingly stated junior scientific colleague V. Yegorov, "that this pump was made 'in contradiction to' the rules set forth in this textbook. And despite this, it sure does work!"

They soon demonstrated to me how it works. The miniature pump which I had held in my palm is capable in just one hour of pumping out a good-sized ladle filled to the brim...with molten metal. There is no other unit in the world which, with such small dimensions, has such a capacity.

The idea of a magnetohydrodynamic pump was first suggested as far back as the middle of the last century by the famous British physicist, Michael Faraday, who passed an electric current through a column of mercury. Now it was only necessary to set up a magnetic field around the mercury to start the liquid metal moving.

However, the first MHD pumps appeared only in our own times, when metallurgists had a need to transfer large quantities of molten metal. There are many pumps for viscous liquids, but which of them will withstand the temperature of molten steel? Here there was a need for an apparatus having neither pistons, nor small turbines, nor in general any moving parts whatsoever.

This is what the MHD pump turned out to be. It is essentially an ordinary electric motor. Only instead of a rotor it has a tubing channel filled with liquid metal or another current-conducting fluid. And when a magnetic field arises around the tubing, the fluid surges forward....



But, although the present-day family of MHD pumps is characterized by great diversity, they also have certain traits in common: imposing dimensions and a relatively modest capacity. And one more thing: operating in each of them are powerful, so-called parasitic currents, which take away a great deal of energy and convert it into heat. To put it more briefly, these are harmful currents and are written about in every textbook. And it is necessary to get rid of them by any method possible.

But are such parasitic currents really so harmful? Would it not be possible to create conditions whereby they would turn out to be helpers? Giving thought to this problem was Candidate of Technical Sciences Yu. Merenkov, head of the magnetohydrodynamic converter laboratory of the section on physical and technical problems of power engineering, Ural Science Center, USSR Academy of Sciences. And he decided to try it out: he placed a metallic plate between two magnets asymmetrically. By all the canons it was impossible to do this. But it turned out fine, inasmuch as it proved to be the case that in the "skewed" magnetic field the parasitic currents tended not so much to be converted into heat as they did to crowd out the contents of the tubing a bit more rapidly. The pressure of the liquid metal became 10 times more powerful, while the efficiency of the pump and its capacity increased sharply.

The dwarf-pump has successfully passed its laboratory tests and is ready for introduction into industry. And it has fine prospects. It promises to become irreplaceable not only in transporting liquid metals but also other viscous, current-conducting fluids. It will replace heavy manual labor involved in filling up casting molds with metal, and it will become an important link in the production of such metals as mercury and magnetite. In a word, it will be useful everywhere where there is a need to handle molten metal flow.

[431-2384]

2384

CSO: 1861

## INDUSTRIAL TECHNOLOGY

### BRIEFS

GIANT CRANE FOR "ATOMMASH"--The designers of the Siberian Heavy Machine-Building Plant have proceeded to develop an overhead crane with an unprecedented load capacity--1,200 tons. It is earmarked for the Volga-Don "Atomash" Plant. This giant crane will be working in the workshop of the reactor vessel equipment, where it will be called upon to lift and, in case of necessity, to tilt the atomic reactors. The "SZTM" [Siberian Heavy Machine-Building Plant] brand of overhead cranes are well known at "Atomash." Recently a letter arrived, addressed to the Siberian machine builders, from V. Pershin, the general director of "Atomash." It states that the overhead cranes produced by the Siberian Heavy Machine-Building Plant deserve high marks. [Text] [Moscow TRUD in Russian 16 Oct 79 p 4] 2384

[457]

CSO: 1861

## HIGH ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

### NEW INDUCTION-TYPE PLASMOTRON

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian Oct 75 p 4

[Article: "The 'Sun' Arrives in the Workshop"]

[Text] An enormous temperature, close to that which exists on the Sun's surface, is being reproduced in industrial engineering processes by induction-type plasmotrons with power 1,000 k-W. Manufacture of the first such Soviet apparatus has been completed at the test-experimental plant of the All-Union Scientific Research Institute of High-Frequency Currents imeni V. Vologdin.

The new equipment, as experiments have shown, has more than 5 times the power of the existing models. It may be used with particular effectiveness in developing new technological processes in metallurgy, power engineering and chemistry for obtaining especially pure materials.

[431-2384]

2384

CSO: 1861

## HIGH ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

### USING LASER BEAMS INSTEAD OF WIRES

Moscow TRUD in Russian 16 Oct 79 p 4

[Article by R. Akhmetov: "Laser Beams Instead of Wires"]

[Text] Telephone communication between one-half of the world's population with the other half could be carried out simultaneously by means of a single laser beam.

In order to transmit information, use is made of light (optical) waves, generated by a laser and passed through a glass fiber. A great deal of success has been achieved by the scientists of the Physics Institute imeni P. N. Lebedev of the USSR Academy of Sciences, where research is being conducted under the direction of A. M. Prokhorov, winner of the Lenin and Nobel Prizes. Utilizing the achievements of Soviet quantum electronics and chemistry, they, working in conjunction with their colleagues at the Institute of Chemistry of the USSR Academy of Sciences, have created a "wire" which is made of ultra-pure glass with marginally low losses of light. Speech, music, television pictures, and digital information can be transmitted through this glass fiber. The principal merit of optical communication lies in its gigantic informational capacity, due to the use of a completely new band of ultra-shortwaves. Only a few dozen conversations can be carried through a pair of ordinary telephone wires. A semiconductor laser, equal in size to the head of a pin, transmits through two glass filaments (each one of which having the thickness of a human hair) 33,000 telephone conversations.

[457-2384]

2384

CSO: 1861

## MARINE AND SHIPBUILDING

### HIGH-QUALITY PRODUCTS CALLED FOR

Moscow TRUD in Russian 9 Oct 79 p 1

[Article: "Produce All Products With the Badge of Quality"]

[Text] The Dal'dizel' Plant is one of the oldest enterprises at Khabarovsk. The plant products--ship engines--are widely known not only in our country but also abroad. Bulgaria and Rumania, Cuba and Vietnam, the African countries and Japan--this is far from a complete list of the addresses to which the diesels and diesel generators are shipped. The State Badge of Quality is placed on each article of the plant. More than 100 persons at the enterprise have won the right to place their own stamp and issue products from the first presentation alone.



Members of the Creative Cooperation Group (From Left to Right)  
Fitter-Assembler Brigade Leader V. Taranov, Fitter-Assembler  
A. Yermak, Engineer V. Oleynik and Fitter-Assembler V. Shatilo

[422-6521]

6521

CSO: 1861



## NON-NUCLEAR ENERGY

### HYDROELECTRIC GENERATOR PRODUCTION REPORTED

Moscow IZVESTIYA in Russian 5 Oct 79 p 2

[Article by V. Surkov, special IZVESTIYA correspondent: "Tested on the Vakhsh River"]

[Text] The new, most efficient electric machine--a hydrogenerator with rating of 300,000 kilowatts with total water cooling--was developed in the USSR and has successfully passed the first production trials. The State Committee accepted it for industrial operation at the Nurekskaya GES.

The specialists and scientists concluded that introduction of such machines at hydroelectric power plants of the country will increase the efficiency of GES and will produce an enormous saving.

The rotating part of the experimental hydrogenerator alone--the rotor--is equal to a six-story building in height. And the rotor weighs 1,750 tons. This giant makes 200 revolutions per minute around its own axis. Water sets the hydrogenerator rotating and also cools it.

The chief designer of the new machine--specialist of the Sverdlovsk plant Uralelektrotyazhmash [Ural Heavy Electrical Machinery Plant] V. Loshkarev, notes that it has become lighter and more compact and that the reliability and life of the hydraulic unit were increased. The machine builders saved 10 tons of copper and 100 tons of steel and reduced the consumption of insulation on a single generator alone.

[422-6521]

6521

CSO: 1861

## NUCLEAR ENERGY

### NUCLEAR POWER PLANT CONSTRUCTION

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Oct 79 p 1

[Article by S. Markosyan: "The Construction Project is Gaining Tempo"]

[Text] The silvery giant towers are visible a few kilometers from Metsamor. The height of each is 110 meters. These are the cooling towers of the Armenian Nuclear Electric Power Station--the firstborn of atomic power engineering of the Transcaucasus. The first unit is already in operation here. The builders and installers are meeting the approaching anniversary of the Great October Socialist Revolution with shock labor watches. They have given their word to turn the second unit with capacity of 410,000 kilowatts over for operation ahead of schedule--on 22 December, Power Engineering Day.

Installation has entered the final phase. The complex brigade of builders of Hero of Socialist Labor Ambartsum Manukyan is completing the framework of the powerful reinforcement for the structural members in the reactor room. The stack of electrical devices is carried out with the mark of "excellent" by the brigade of Sergey Akopyan of Gidrosantekhmontazh [expansion unknown]. Alongside, in the machine room, they have begun idling of the individual systems of turbogenerator No. 3. The fourth turbo unit is being assembled here.

The installers of the section of the Transcaucasian installation administration of the Gidroelektromontazh Trust are faced with extensive problems. The chief of the section is Samvel Darbinyan. He also considers those objects completed at which the shock force of the section was concentrated--the brigade of Suren Arutyunyan, Viktor Markushev and Norayr Mkrtchyan. They installed the electrical equipment which provides all the necessary operations for starting the reactor and turbogenerators, are completing the installation of the block transformers with capacity of 250,000 kilovolts-amperes and are installing the KIP [monitoring and measuring instruments] and automatic devices. All 320 electricians are part of contract brigades. The plan of installation work has been overfulfilled 1.5-fold

The hundreds of kilometers of pipelines and cables require special attention. The Armyanskaya AES is located in a zone of high seismicity, which places special requirements on every worker and on everyone together.

The construction project has emerged into the straightaway. But the suppliers sometimes interrupt the tempo at this stage.

"A new level of the reinforcement must be tied together tomorrow, but it is not here," A. Manukyan says sadly. "I went to consult with the construction administration. There is no suitable metal and the rollers of the Rustavo Metallurgical Plant are letting us down. We turned to the suppliers with a call to organize a competition by the 'workers relay race.' Unfortunately, only a few responded."

I heard this alarming conversation on this topic many times at the evening operational meeting of chief construction engineer A. Babayan. The list of "debtors" is being reduced very slowly. And now included among them are the Chekhov Plant Energomash, the Taganrog Plant Krasnyy Kotel'shchik, the Irkutsk cable workers, the Leningrad Elektropul't Plant and the Rustavo, Makeyevko and Chelyabinsk Metallurgical plants.

It would be untrue to say that no one is helping the construction project at all. There is help and a significant bit of it by the specialists. I met them during the night shift--installers of Sevzapenergomontash [expansion unknown] from the Kol'skaya AES and Kavkazenergomontazh. Reinforcement from Sumgait, Gardaban' and Krasnodar came to help them.

Everyone here hopes that the suppliers will also seek out capacities for correcting the situation at an important power engineering object. After all, the second unit of the Armyanskaya AES is essentially a new power plant which will soon be included among the operating. The capacity of the nuclear power plant will double.

[422-6521]

6521

CSO: 1861

## NUCLEAR ENERGY

### THERMONUCLEAR REACTION INDUCED BY LASER

Moscow IZVESTIYA in Russian 5 Oct 79 p 2

[Article: "Scientific Contacts"]

[Text] Scientists of the Physics Institute imeni P. N. Lebedev of the USSR Academy of Sciences managed to induce a thermonuclear reaction by using a laser. They achieved this by concentrating beams of apparatus uniformly arranged around the circumference on a spherical target several microns in diameter.

As they told a TASS correspondent at FIAN, one of the properties of laser emission is used to induce this reaction: the possibility of focussing it on small volumes of matter. The target is several milligrams of thermonuclear fuel--a deuterium and tritium mixture. When exposed to a laser pulse, conditions are created in it for the beginning of a thermonuclear reaction--temperature of millions of degrees and fuel density exceeding hundreds of times the density of the solid.

The investigators encountered significant difficulties during the work. For example, it is impossible to use ordinary spherical lenses to concentrate the laser beams on such a small area. So-called aspherical objectives which provide the necessary degree of beam focussing were used to achieve the desired effect. This optical device, developed and manufactured by specialists of the Central Institute of Optics and Spectroscopy of the German Democratic Republic Academy of Sciences, as well as the automatics for controlling the laser emission, contributed to a significant degree to the success of the investigators.

The cooperation of scientists of the two countries in the field of quantum electronics has continued for more than 10 years. As a result improved devices have been developed which find broad application in fiber-optics communications lines, computer technology and medicine. The 1979 Prize of the USSR and German Democratic Republic Academies of Sciences was awarded to the author's collective of scientists working on this problem for the best joint work in physics.

Fruitful cooperation with Soviet scientists engaged in the leading positions in physics contributed to a significant extent to rapid development of quantum electronics in the GDR. Further development and deepening of these ties will mutually enrich the scientific-technical arsenal of both countries and will make it possible to achieve new successes in introduction of the advances of quantum electronics to the national economy.

[422-6521]

6521

CSO: 1861



USSR

UDC 629.7.064.5:631.3

COMPARATIVE EVALUATION OF VARIANTS OF ELECTRICAL EQUIPMENT FOR VEHICLES

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian  
No 5, Sep-Oct 79 pp 122-128 manuscript received 13 Dec 78

ZHUKOV, YU. N.

[Abstract] The mathematical apparatus is shown for a comparative evaluation, on the basis of fuel economy, of electrical equipment serving airborne vehicles. Differential equations of kinetics and mass balance are used to calculate the masses of fuel necessary for transporting a payload mass, either variable or constant, for covering the energy losses in the electrical equipment and for forced cooling of this equipment--each component of the fuel requirement being a function of time generally different during different stages of a flight. A typical application of the derived formulas illustrates how electrical equipment can be selected on the basis of minimum fuel requirement and how the necessary fuel supply can be determined before takeoff. Figure 1; references 3 Russian.  
[468-2415]

USSR

UDC [538.3:621.333]001.2

VERTICAL INSTABILITY OF AN ELECTRODYNAMIC SUSPENSION SYSTEM

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian  
No 5, Sep- ct 79 pp 176-178 manuscript received 9 Nov 78

KOCHETKOV, V. M., Leningrad

[Abstract] The principle of electrodynamic levitation can be effectively utilized in high-speed ground transportation for suspending a vehicle. One problem, under consideration here, is the stability of such a suspension system with respect to vertical vibrations which may occur at high horizontal velocities. The problem is analyzed by letting an electromagnet in the form of a current-carrying rectangular frame parallel above a bedplate move parallel to the latter at a constant velocity. After the equation of diffusion of the magnetic field has been solved for the Fourier transform of the magnetic induction vector, in coordinates tied to the stationary bedplate, the force is calculated which eddy currents in the bedplate exert on the frame. The motion of the frame or vehicle is found to become unstable at velocities of 60-90 m/s already, for typical system parameters, with the instability threshold depending on the bedplate thickness. The increment of vibration amplitude is found to be small, however, so that an auxiliary suspension with a mechanical damper can easily stabilize the system. Figure 1; references 3: 2 Russian, 1 Western.  
[468-2415]

USSR

UDC 658.26:621.311.2

## TECHNICAL-ECONOMIC ASPECTS OF INSTALLING CENTRALIZED HEAT SUPPLY FROM ATOMIC BOILERS

Moscow ATOMNAYA ENERGIYA in Russian Vol 46, No 1, Jan 79 pp 3-9 manuscript received 5 Jun 78

YEMEL'YANOV, I. YA., BATUROV, B. B., KORYTNIKOV, V. P., KORYAKIN, YU. I., CHERNYAYEV, V. A., KOVLYANSKIY, YA. A. and GALAKTIONOV, I. V.

[Abstract] The technical feasibility of reliably and safely supplying heat from nuclear sources has already been established in the Bilibino (USSR) and the "Agesta" (Sweden) atomic thermoelectric power plants. Here the economic feasibility of using atomic boiler plants for this purpose, alone or jointly with atomic thermoelectric power plants, is analyzed in terms of geographic and demographic factors as well as a competitive alternative to boilers operating on fossil fuel. The analysis takes into account the technical capabilities of atomic boiler plants based on various types of reactors, most promising being an atomic-chemical boiler plant based on a high-temperature reactor and using a gaseous  $H_2+CO_2+CO$  mixture as the coolant. With adequate operation and distribution facilities, such a plant could provide a centralized source of heat supply for a large number of small users. Figures 5; references 6: 5 Russian, 1 Western. [472-2415]

USSR

UDC 539.173.84

MEASUREMENT OF CROSS SECTIONS FOR  $Pu^{240}$  AND  $Pu^{242}$  FISSION RELATIVE TO THE CROSS SECTION FOR  $U^{235}$  FISSION OVER THE 0.127-7.4 MeV RANGE OF NEUTRON ENERGY

Moscow ATOMNAYA ENERGIYA in Russian Vol 46, No 1, Jan 79 pp 35-40 manuscript received 30 Jan 78

KUPRIYANOV, V. M., FURSOV, B. I., MASLENNIKOV, B. K., SURIN, V. M. and SMIRENKIN, G. N.

[Abstract] This one in a series of studies was made to determine the cross sections for fission of uranium and plutonium isotopes by fast neutrons. Measurements were made in electrostatic accelerators with the reactions  $Li^7(p,n)Be^7$  ( $E_n = 0.127-0.342$  MeV),  $T(p,n)He^3$  ( $E_n = 0.313-3.4$  MeV) and  $D(d,n)He^3$  ( $E_n = 3.6-7.4$  MeV) serving as neutron sources, using a twin-chamber detector so that the ratios of  $Pu^{240}/U^{235}$  and  $Pu^{242}/U^{235}$  cross section could be determined. The first part of the experiment established the energy dependence of these ratios and the components of the neutron

background, with special attention paid to spontaneous fission below the threshold. The second part of the experiment measured the absolute values of these ratios at four different energy levels throughout the range, also with  $\text{Pu}^{239}$  replacing  $\text{U}^{235}$  in the method of isotopic admixtures. The results, statistically evaluated, are tabulated including errors and corrections, for comparison with the results in other reports. Tables 4; references 12: 5 Russian, 7 Western.  
[472-2415]

JR

UDC 621.039.54

#### THERMAL CONDUCTIVITY OF THE CONTACT BETWEEN A $\text{UO}_2$ FUEL ELEMENT AND ITS CLADDING

Moscow ATOMNAYA ENERGIYA in Russian Vol 46, No 1, Jan 79 pp 45-47 manuscript received 27 Oct 77

SAMSONOV, B. V. and SEREDKIN, S. V.

[Abstract] The thermal conductivity of the contact between a  $\text{UO}_2$  fuel element and its cladding was measured in two earlier laboratory experiments, one in the Soviet Union, by other authors. Here the results are evaluated on the basis of a mathematical experiment with a complete factor plan. The factors found to be significant are: linear power density (100-500 W/cm) and initial clearance (0.045-0.18 mm), also pressure and thermal conductivity of the filler gas, pressure of the coolant, porosity of the  $\text{UO}_2$  core, cladding diameter and thickness, and microhardness of the cladding material. A regression equation is obtained from a 4-factor 2-level plan yielding independent estimates of all linear effects as well as all binary and ternary interaction effects. The width of the initial "cold" clearance is found to strongly influence the rate at which the "hard" component of thermal conductivity in the clearance increases with increasing linear power density. As the latter increases from 100 to 500 W/cm, the "hard" thermal conductivity increases from 0.07 to 0.12 W/(cm<sup>2</sup>·°C) when the initial clearance is 160  $\mu\text{m}$  wide and from 0.07 to 0.4 W/(cm<sup>2</sup>·°C) when it is 10  $\mu\text{m}$  wide. Figures 2; references 3: 2 Russian, 1 Western.  
[472-2415]

## LASER DRIVEN FUSION: OUTLOOK FOR POWER APPLICATIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian  
No 5, Sep/Oct 79 pp 16-23 manuscript received 17 May 79

KALININ, A. V., Moscow

[Abstract] The four main applications for laser fusion reactors are: "pure"-fusion electric power plants, hybrid "fusion-fission" electric power plants, breeders, and production of nonnuclear synthetic fuels. Here major developments in these areas are surveyed from the standpoints of physics, engineering, technology, and power. Two "pure" laser fusion electric power plants are compared: one version proposed by the Institute of Physics and the Institute of High Temperatures, both at the USSR Academy of Sciences, one version proposed by the University of Wisconsin (SOLASE program). Also compared are the hybrid laser thermonuclear electric power plant proposed by these two Institutes of the USSR Academy of Sciences and the hybrid laser thermonuclear breeder proposed by the University of Rochester, both operating on the same principles but in different technological modes. Although the performance characteristics of compared plants differ, the physicotechnical approaches to their design are essentially the same in each case. There is, for instance, a common trend toward using atomic hydrogen as a general-purpose secondary energy carrier and fuel. The design and performance characteristics of the IRTC laser fusion plant for radiolytic production of hydrogen illustrate the feasibility and the advantages of this concept. Figure 1; tables 3; references 12: 2 Russian, 1 Czech, 9 Western.  
[468-2415]

## LIGHT YIELD OF CsI(Tl) AND CsI(Na) CRYSTALS UPON BOMBARDMENT WITH CHARGED PARTICLES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 86-88 manuscript received 16 Aug 77

DORCHIOMAN, D., KONSTANTIN, M., LAZAROVICH, D., MUNTYANU, I., OGANESYAN, K. O. and POROKHOVOY, S. YU., Joint Institute of Nuclear Research, Dubna

[Abstract] The light yield of crystals of CsI(Tl) and CsI(Na) is measured for protons, deuterons and alpha particles in the 3-15 MeV interval. Measurements were performed on beams of tandem generators of the Institute of Nuclear Physics at Bucharest using protons, deuterons and alpha particles elastically scattered at an angle of  $90^\circ$  on a gold foil target. The



main source of possible systematic errors, instability of the spectrometric channel, was eliminated by recording signals from alpha particles from a  $^{241}\text{Am}$  source as a bench mark simultaneously with recording of particles from the accelerator. Particular emphasis was given to evaluation of the surface insensitive layer of specimens of the scintillators studied. The results of the measurement indicate the possibility of using crystals of cesium iodide for identification and spectrometry of charged particles with energies up to several dozens of MeV. Figures 4, References 4: 1 Russian, 3 Western.  
[471-6508]

USSR

UDC 621.311.25:621.039

# EFFECT THAT WATER TREATMENT OF THE SECOND LOOP OF THE VVER-440 WATER-MODERATED WATER-COOLED POWER REACTOR HAS ON THE POSSIBILITIES FOR INCREASING REACTOR CAPACITY

Moscow TEPLOENERGETIKA in Russian No 9, 1979 pp 41-42

VOLKOV, A. P., TROFIMOV, B. A., IGNATENKO, YE. I., PASHEVICH, V. I.,  
ABAROVSKIY, I. I., ZVERKOV, V. V. and LITVINOV, A. N.

[Abstract] Considering that the cleanness of the heat transfer surfaces of steam generators at atomic power stations must meet more rigorous requirements than the cleanness of the surfaces of boilers in conventional power stations, since corrosion deposits on these surfaces reduce the heat transfer coefficient, the nature of the water used in the steam generators of the second loop of the VVER-440 water-cooled water-moderated reactor at the Kola Atomic Electric Power Station was investigated in relation to the deposits it formed in the tubes. It was established that the use of water with a neutral pH index resulted in the formation of undesirable deposits in the tubes. Accordingly, it was decided to convert to treating the feedwater with an ammonia-hydrazine mixture. The amount of ammonia added to the feedwater was 200-500 mg per kg ( $\text{pH} = 8.8-9.2$ ), and the amount of hydrazine, 30-100 mg/kg. The ammonia was added to maintain a  $\text{pH}$  of  $9.1 \pm 0.1$  and to create an alkalinity that would promote the deoxygenation of feedwater by the hydrazine. The combined effect of these two substances is intended to "rinse away" the deposits forming on heat-transfer surfaces, to prevent the formation of iron-oxide and copper deposits in the steam-generator tubes, and to form a protective (passivating) film on the surfaces of the feedwater-condensate channels following the removal of corrosion products. Operating trials with the new mixture showed that the thickness of corrosion products in the second loop diminished markedly (iron, to 20-40  $\mu\text{g/kg}$  and copper, to 5-10  $\mu\text{g/kg}$ , compared with the earlier up to 100  $\mu\text{g/kg}$  Fe and up to 60  $\mu\text{g/kg}$  Cu). This also made it possible to reduce the inlet temperature of the in-pile coolant to 264-265°C compared with the 268-270°C envisaged in the original design, which, in its turn, raises the question of increasing the capacity of VVER-440 units by 3-4% above their rated capacity. Figures 3; references 4 Russian.  
[449-1386]

USSR

UDC 621.711.22.002.51:621.165.6

## ACCELERATED COOLING OF A MONOBLOCK WITH A T-100-130 TURBINE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 7, Jul 79 pp 29-32

IVANOV, V. A., doctor of technical sciences, BOROVKOV, V. M., candidate of technical sciences, NOVITSKIY, YU. I., engineer, YEREMENKO, L. YA., candidate of technical sciences, SHIROKOV, V. N. and FILIMONOV, V. F., engineers, Leningrad Polytechnical Institute, Northern Heat and Electric Powerplant, Leningrad Power System

[Abstract] During studies at Northern Heat and Electric Powerplant of the Leningrad Power System, in cooperation with Leningrad Polytechnical Institute, a method has been developed allowing rapid cooling of a monoblock with a T-100-130 turbine. The primary distinguishing feature of the method is cooling under load with decreased fuel feed, significantly reducing the parameters of the steam in the boiler. The steam temperature drops to approximately 350°C, the pressure to 25 kgf/cm<sup>2</sup>, minimizing the duration of the second stage of cooling, during which the rate of decrease in temperature is 5 to 10 times less than during cooling under load. The new method allows cooling to be completed in 12 hours with minimum heat losses. Figures 5, References 10 Russian.  
[474-6508]

USSR

UDC 621.165-783.617:62-71.004.13

## FORCED COOLING OF THE K-500-240-2 TURBINE DURING SHUTDOWNS

Moscow ELEKTRICHESKIYE STANTSII in Russian No 7, Jul 79 pp 35-40

POKHORILER, V. L., PALEY, V. A., candidates of technical sciences, DANILOV, S. N., FISKIND, E. E., SHAKIROV, A. SH. and YUDIN, S. M., engineers, Ural Technical Administration for Power Engineering, Khar'kov Turbine Plant

[Abstract] The K-500-240-2 turbine is to be widely used for the development of power engineering in the coming years. This article discusses the results of a study of forced cooling of the turbine performed by the Khar'kov Turbine Plant and the Ural Enterprise of the All-Union Technical Administration for Power Engineering. Natural cooling from the operating temperature to 150°C requires over 7 days. Forced cooling of the body of the entire unit requires about 6 days under the same conditions. The following methods were tested: cooling under loads; cooling of the turbine with air after stopping; cooling of the turbine with steam after stopping; combined methods of cooling including cooling under loads in the first stage and cooling of the turbines with steam or air after stopping in the

second stage. The methods can be used either individually or in various combinations. Cooling under load in the first stage and cooling by blowing of air through the turbine in the second stage is the combination most frequently used. Figures 3, References 10 Russian.  
[474-6508]

USSR

UDC 621.311.22.002.51-7.002.234.004.13

#### COOLING OF THE 300 MW POWER UNIT WITH SLIDING STEAM PRESSURE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 79 pp 13-16

ROSSIKHIN, L. YA., SHNYAKIN, A. V. and LIDER, O. O., engineers, Soviet Middle Asian Technical Council on Energy, Syrdar'ya Regional Electric Powerplant

[Abstract] The process of opening the body of the high and medium pressure cylinders and bearings, maintenance of lubrication and regulation systems and associated cooling of turbines to a temperature at which the shaft rotating device can be disconnected and oil feed stopped are described. The process of forced rapid cooling of power units can be arbitrarily divided into two stages: reducing the pressure and temperature of live steam at the turbine inlet, and ventilation of the boiler and turbine with air after they are shut down. During the first stage, for a part of the time there is a two-phase medium in the steam-water line, which extends to the intake of the convective stage of the primary steam superheater. When cooling is performed as described in this article, measurements should be performed to determine the dynamic head in the economizer evaporator heating surface. Figures 2, References 5 Russian.  
[473-6508]

USSR

UDC 621.165:621.313.322-81:621.797.001.12

#### MAINTENANCE CYCLE OF THE K-160-130 KHTGZ TURBINE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 79 pp 19-23

AVERBAKH, YU. A., BONESKO, V. A., engineers, NAYMANOV, O. S., candidate of technical sciences, RABINOVICH, YE. A. and TSELYUBA, S. A., engineers, Khar'kov Branch, Central Design Bureau of Main Administration for Power Equipment Maintenance

[Abstract] A study is made of the possibility of increasing the time between maintenance cycles of the K-160-130 KHTGZ turbine. The initial materials used in the study were statistical data on all types of repair and maintenance performed since the beginning of operation of the turbine

through 1977. It is found that a maintenance cycle of 5 to 6 years with one intermediate middle-echelon maintenance is justified by the history of reliability of the turbine. This increase in the time between overhauls should not significantly influence the time required to perform overhauls. As the time between overhauls is increased, additional diagnostic tests should be performed on the machine between overhaul cycles. Figures 2, References 4 Russian.  
[473-6508]

USSR

UDC 621.187.124:658.264.004.69

#### SPECIFICS OF ADJUSTMENT AND OPERATION OF THE DV-800 VACUUM DEAERATORS

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 79 pp 56-58

KRASAVIN, A. V. and KUKIN, N. A., engineers, Soviet Middle Asian Technical Council on Energy

[Abstract] This article presents the results of adjustment and operation of one version of deaeration installation used in the hot water supply system of the Gor'kiy Motor Vehicle Plant Heat and Electric Powerplant. Cross-sectional diagrams of the deaerators are presented, both before and after redesign performed by the plant. In order for type DV deaerators with throughputs of 400 t/hr and more to operate with pressures in the apparatus of 0.075-0.08 kgf/cm<sup>2</sup>, the area of the bubble sheet was increased to 0.25 m<sup>2</sup> for each 400 t/hr of throughput. Unsatisfactory operation of vacuum deaeration installations is frequently caused by leaks in glands and water indicator glasses. Leaks must be fixed as quickly as they develop.  
[473-6508]

USSR

UDC 621.315.016.2.027.8.004.67

#### REPAIR OF 220-500 kV HIGH-PRESSURE CABLE LINES

Moscow ELEKTRICHESKIYE STANTSII in Russian No 11, Nov 79 pp 55-59

MAKIYENKO, G. P., engineer, Kamskiy Cable Plant

[Abstract] Approximately fifty high-voltage high-pressure cable lines are operating in hydroelectric power plants throughout the Soviet Union, and more are to be installed. The cable equipment in these lines consists, essentially of a seamless steel-tube armor containing the conductor strands, potheads, copper-tube splitters, splitting or splitting-connecting sleeves, splicing sleeves, cable leads to transformers, and a pressure

level maintenance system. The standard conductor sizes range from 300 to 625 mm<sup>2</sup> for 220kV, from 400 to 625 mm<sup>2</sup> for 330 kV, and from 500 to 625 mm<sup>2</sup> for 500 kV, also custom-made specialty 700 mm<sup>2</sup> conductors being now available and 850-1000 mm<sup>2</sup> conductors to be produced shortly. The strands are shielded, insulated, and shielded again. Two protective copper slide wires and a temporary lead sheath are slipped over the cable core before it is pulled through the steel tube. Equipment and techniques have been developed for the repair of these cable lines in service. This includes fault detection, usually by the loop method to establish the faulty line segment and by the acoustic method to establish the exact fault location. There follow replacement of the faulty segment, capping and flanging of the steel tube, freezing and curing of the cable with liquid nitrogen while preventing any leakage, sampling and checking, oil replacement, and unfreezing. The total repair operation, including replacement of a cable segment of standard manufacturing length without discontinuity in service, takes 14-16 days and requires a crew of 32-35 persons. Removal of the temporary sheath after repair is most tedious and a machine can replace here the manual labor of 14-15 persons. Figures 3; tables 2; reference 1 Russian. [492-2415]

USSR

UDC 621.316.545.027.850

#### SUSPENSION-TYPE 500 kV DISCONNECT SWITCHES

Moscow ELEKTRICHESKIYE STANTSII in Russian No 11, Nov 79 pp 75-79

YEVTUSHENKO, V. A., candidate in technical sciences, LIKHACHEV, P. A., candidate in technical sciences, and RUBANOV, G. I., engineer, All-Union State Institute of Planning of Electrical Equipment for Heat Engineering Structures, All-Union Power System Engineering Administration

[Abstract] Since recently it is possible to reduce the number of circuit breakers and thus the cost of outdoor distribution equipment in large state regional electric power plants by duplexing of transformer blocks through disconnect switches. The kinematic linkage controlling the movement of poles and contactors of suspension-type RPD switches, for disconnecting TDTs-400000/500 transformers under no load from TRDN-25000/35 transformers supplying the station auxiliaries in the Kostromskaya Plant, has been redesigned so as to effect sequential rather than simultaneous on and off switching of all three phases, either arclessly or with little arcing only. The kinematic linkage of RP switches for disconnecting TDTs-400000/500 transformers under no load in the Ryazanskaya Plant had already been redesigned in 1977. The new designs are adapted for serial manufacture of these disconnect switches in the 500 kV version, or to be used in 330 kV and 750 kV outdoor distribution systems. Figures 2; references: 2 Russian. [492-2415]



RESULTS OF STARTUP OF POWERFUL HEAT SUPPLY UNITS AT THE MOSCOW POWER  
UNION's TETS-22 HEAT AND ELECTRIC POWERPLANT

Moscow ENERGETIK in Russian No 9, Sep 79 pp 6-8

ZVEGINTSEV, A. V., SAMARENKO, V. N., BROVKIN, B. A. and KUDRYAZYY, V. V.,  
engineers

[Abstract] Three powerful heat supply units operating with supercritical steam parameters and intermediate reheating were put in operation at TETS-22 in Moscow during 1972-1973. By 1 January 1978, they had produced 16.1 billion kW·hr of electric power and supplied some 16.8 million Gcal of heat to secondary consumers. A schematic diagram of one of the units, with a type TPP-210A boiler and a type T-250/300-240 turbine, is presented. The basic elements of the equipment used in each unit are described. After the units were put in operation, a number of shortcomings were discovered which prevented normal operation. These included: accumulation of slag on the heating surfaces; unstable operation of the heating tubes; low frequency vibration of the turbine rotors; reduced output of boilers; breaking of vanes in the axial DO-31.5 smoke pumps; breaking of gears in reducing transmissions; and steam leaks. Steps taken to eliminate these difficulties are described.

[478-6508]

USSR

THE BEST OPERATORS OF THE T-250/300-240 POWER UNITS OF THE MOSCOW HEAT  
AND ELECTRIC POWERPLANT

Moscow ENERGETIK in Russian No 9, Sep 79 pp 17-18

UNSIGNED

[Abstract] This article honors workers at the Moscow Heat and Electric Powerplant using the relatively new T-250/300-240 turbines who have achieved the best results in plant operation. No details of plant operation are given. Personnel honored include: Yuriy Aleksandrovich Ivanov, Nikolay Nikolayevich Seregin, Anatoliy Andreyevich Petrushin and Petr Ivanovich Tryapitsyn. Photographs are included.

[478-6508]

## ALKALINE AND NEUTRAL OPERATING MODES IN A 200 MW POWER UNIT WITH AN AIR-CONDENSATION INSTALLATION

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 79 pp 37-39

VASILENKO, G. V., SUTOTSKIY, G. P., candidates of Technical Sciences and MAZUROVA, O. K., engineer

[Abstract] A description is presented of a 200 MW power unit including a "dry" cooling tower, in which 22,000 tons of cooling water are circulated per hour through 57,000 aluminum pipes 15 m in height and 14 X 1 cm in diameter. The thermal system of this power unit contains elements made of dissimilar metals: steel, aluminum and copper alloys. This complicates the selection of the optimal water-chemical regime, since these three materials require different values of pH for minimal corrosion. Studies were performed in two stages to determine the optimal pH and water-chemical regime to minimize corrosion of the entire system. It is concluded that a neutral-acid regime, in combination with high pH of boiler water reduces corrosion of the aluminum and steel surfaces of the condenser and feed section. Figures 3, References 7 Western.

[476-6508]

## PROCESSES LEADING TO DEGRADATION OF THE ELECTROPHYSICAL CHARACTERISTICS OF PHOTOVOLTAIC CELLS AFTER LENGTHY SERVICE

Tashkent GELIOTEKHNIKA in Russian No 5, 1979 pp 7-12

DALETSKIY, G. S., KARPENKO, I. V., KOLTUN, M. M., KARPUKHIN, V. A., KSENDZATSKAYA, YU. N., KUZNETSOV, V. M., RYABIKOV, S. V. and TYKVENKO, R. N., "Order of Red Labor's Banner" All-Union Scientific Research Institute of Current Sources

[Abstract] An experimental study was made concerning the photoelectric stability in service of 10-30  $\mu$ m thick polycrystalline n-type CdS or CdTe films with respectively  $\text{Cu}_2\text{S}$ -CdS or  $\text{Cu}_2\text{Te}$ -CdTe heterojunctions forming the potential barrier, the p-type  $\text{Cu}_2\text{S}$  or  $\text{Cu}_2\text{Te}$  layer being produced by a chemical substitution reaction or by vacuum deposition. This upper p-type layer is the component of such solar cells most vulnerable to degradation in service, not so much in storage away from ultraviolet radiation, mainly due to phase transformation. These can be avoided by holding the operating temperature below 100°C and that of copper diffusion below 60°C. Technologically subsequent phase transformations can be minimized by making the substitution reaction fast or by discrete spraying rather



than thermal deposition on a flawless substrate. Optical glass with 2%  $\text{CeO}_2$  is used for hermetically enclosing these solar cells, also silicon solar cells, to keep out ultraviolet radiation (without filters) as well as moisture and thus prevent darkening of the optical adhesive coating as well as corrosion of the electrical contact tabs. Coating layers of low-molecular silicon rubber have been found to be highly resistant to ultraviolet radiation and to bombardment by nuclear particles, more so than epoxy layers, but acrylopolysiloxanourethane to be the best adhesive for this protective glass. The conclusions are based on laboratory tests with a xenon lamp simulating the solar ultraviolet radiation at a 10 times higher intensity as well as by field tests on satellites ("Elektron" and "Mol'niya-1") in the Earth's radiation belts and in outer space. Figures 4; references 8: 4 Russian, 4 Western. The article was presented at the 1977 International Electrical Engineering Congress in Moscow. [490-2415]

USSR

UDC 621.383.44

EFFECT OF HIGH-LEVEL SOLAR EXCITATION ON THE OPTIMUM PERFORMANCE PARAMETERS OF  $\text{P-Al}_x\text{Ga}_{1-x}\text{As-P-GaAs-n-GaAs}$  HETEROPHOTOCELLS

Tashkent GELIOTEKNIKA in Russian No 5, 1979 pp 13-16

AZIMOV, S. A., MIRZABEYEV, M. M., RASULOV, K., ISKANDEROV, A. and TURSUNOV, M., Physicotechnical Institute imeni S. V. Starodubtsev, Academy of Sciences of the Uzbek SSR

[Abstract] Heterophotocells based on  $\text{GaAs-AlGaAs}$  with an intermediate radiation converting stage and with either an intermediate diffusion layer or a forbidden band smoothly widening toward the exposed surface have been found to be able to operate at high temperatures and irradiation levels. Here the performance of  $\text{P-Al}_x\text{Ga}_{1-x}\text{As-P-GaAs-n-GaAs}$  ( $x = 0.7-0.8$  mole fraction) heterophotocells was studied, specimens having been produced by doping with zinc and liquid-phase epitaxy with forced cooling of solid solution  $\text{P-Al}_x\text{Ga}_{1-x}\text{As}$  layers on (100)-oriented  $\text{n-GaAs}$  substrates doped with tellurium. The test apparatus consisted of a parabolic projection reflector (reflection coefficient 0.862) with a 950 mm diameter and a 367.1 mm focal length, a sun tracking servomechanism, and measuring instruments. The open-circuit voltage, the short-circuit current and the optimum power were measured as functions of the radiation flux density  $E$  over the  $0-10,000 \text{ mW/cm}^2$  range, with cooling (constant temperature  $60^\circ\text{C}$ ) and without cooling (temperature rising to  $200^\circ\text{C}$ ). While the voltage was found to follow the empirical relation  $V = aE^b$  with  $a = 618$  and  $b = 0.06$  (reaching 1.1 V) with the temperature constant, but peaking to 0.865 V at  $2000 \text{ mW/cm}^2$  with the temperature rising, the current and the power were found to increase linearly with the radiation flux density in both cases, up to

some level of the latter different in each case, and then to increase faster before peaking. Figures 2; table 1; references: 6 Russian. The article was presented at the 1978 Second All-Union Conference in Ashkhabad on Physical Processes in Semiconductor Heterostructures. [490-2415]

USSR

UDC 621.282.44

ELECTRIC AND PHOTOELECTRIC CHARACTERISTICS OF  $\text{Cu}_2\text{S}$ -CdS HETEROPHOTOCELLS PRODUCED ON STOICHIOMETRIC CdS FILMS

Tashkent GELIOTEKHNKA in Russian No 5, 1979 pp 17-22 manuscript received 13 Oct 78

AKRAMOV, KH. T. and YULDASHEV, B. D., Tashkent State University imeni V. I. Lenin

[Abstract]  $\text{Cu}_2\text{S}$ -CdS photovoltaic cells are best produced by the chemical process with low-resistivity cadmium-rich layers of CdS crystals in a CuCl solution, with additional heat treatment for conversion of CdS to  $\text{Cu}_2\text{S}$  at the surface. This heat treatment stimulates diffusion of copper into CdS and formation of an impurity level, a main cause of variance in the electric and photoelectric characteristics of such heterophotocells. Here this problem was studied on  $\text{Cu}_2\text{S}$ -CdS cells with stoichiometric CdS films without heat treatment, to eliminate that factor. Their current-voltage and capacitance-voltage characteristics were measured as well as temperature dependence of the open-circuit voltage and wavelength spectrum of the short-circuit current. Three kinds of heterophotocells are distinguishable in terms of the trend of the voltage-temperature and the current-wavelength characteristics. The results indicate that  $\text{Cu}_2\text{S}$ -CdS heterophotocells can be produced chemically without subsequent heat treatment, inasmuch as the variance in their performance characteristics is due to recombination levels, while their photosensitivity is determined by absorption of light in the wide-band (CdS) semiconductor and in the narrow-band ( $\text{Cu}_2\text{S}$ ) semiconductor respectively. Figures 6; table 1; references: 5 Russian. [490-2415]

## DEPENDENCE OF THE TEMPERATURE CHARACTERISTICS OF SILICON PHOTOVOLTAIC CELLS ON THE RESISTIVITY OF THEIR BASE

Tashkent GELIOTEKHNIKA in Russian No 5, 1979 pp 23-29 manuscript received 10 Nov 78

DOROSHENKO, V. G., ZAKS, M. B., KLIMOVA, G. I., RUSSKIKH, YE. S. and STEPANOVA, Z. A., Krasnodar

[Abstract] An experimental study of the steady-state temperature characteristics of photovoltaic cells with an  $n^+-p$  and  $n^+-p-p^+$  structure was made, covering the 100-400 K temperature range, for the purpose of determining the dependence of these characteristics on the resistivity of the base layer. The test specimens were produced from p-type silicon with resistivity ranging from 0.08 to  $45\Omega\cdot\text{cm}$ , by diffusion of phosphorus and boron from doping solutions to a 0.7 or  $1\mu\text{m}$  depth respectively. A quantitative evaluation of the results reveals that the open-circuit voltage decreases but its temperature coefficient increase with increasing resistivity of the base layer, while the already very small temperature coefficient of the short-circuit current decreases. Also the temperature sensitivity of these cells is found to depend on the resistivity of the base layer, especially around 300 K, with an increase of this resistivity causing the optimum temperature of conversion to shift downward. A further analysis of the failure process in these cells indicates that an increase in the resistivity of the base layer, without change in the relative junction resistance, will slow down the rate of degradation during temperature cycling. This improvement is particularly pronounced when the resistivity of the base has been increased from 5 to  $45\Omega\cdot\text{cm}$  and the series resistance of the device increases then only from 0.6 to  $1.2\Omega$ . Figures 3; tables 2; references 13: 8 Russian, 5 Western. [490-2415]

SERVICE CHARACTERISTICS OF SOLAR BATTERIES BUILT WITH  $\text{Cu}_{2-x}\text{S}$ -CdS CERAMIC PHOTOVOLTAIC CELLS

Tashkent GELIOTEKHNIKA in Russian No 5, 1979 pp 34-37 manuscript received 31 Mar 78

MARCHENKO, A. I., STEPKO, I. I., FEDORUS, G. A. and SHEREMETOVA, G. I., Institute of Semiconductors, Academy of Sciences of the Ukrainian SSR

[Abstract] Much attention is now paid to economic conversion of solar energy and efforts are underway to reduce the manufacturing cost of photovoltaic cells as well as to find new materials less costly than

silicon and GaAs. Promising substitutes are  $AIIB^{VI}$  compounds such as CdS. Batteries of ceramic solar cells based on CdS have already been studied extensively. Here the results of such studies are reported pertaining to a 40-cell series-parallel array tested in the laboratory and two banks of twenty 25-cell series arrays field tested in Turkmenia and the Ukraine respectively since 1975. Diurnal measurements of the basic performance parameters, open-circuit voltage and short-circuit current, also of the incident solar radiation density for reference indicate an efficiency reaching 4% and only 15-20% degradation so far. Hermetic sealing of these cells in protective glass reduces wear of the upper cell layer due to sand, wind, humidity and rain, high temperatures and high radiation levels. However, the mechanical strength of such a structure is too low and the active area of the device is small. Figures 4; references: 7 Russian. [490-2415]

USSR

UDC 621.472

#### AN AUTOMATIC INSTRUMENT FOR MEASURING THE QUANTITY OF SOLAR RADIATION

Tashkent GELIOTEKNIKA in Russian No 5, 1979 pp 56-58 manuscript received 10 Jul 78

BURTOV, YA. L., BELYAYEV, YU. M., KOSTENKO, YU. A. and TOLPENKO, S. P., Krasnodar

[Abstract] An automatic 3-channel general-purpose instrument IRS-1 has been developed for measuring the intensity of solar radiation in  $W/cm^2$  or  $cal/cm^2 \cdot min$  and the quantity of solar radiation in  $W/m^2 \cdot h$  or  $cal/cm^2$ . It also records the quantity of solar radiation in excess of the upper of two set levels and the time at which that upper level has been exceeded. The instrument includes a photoreceiver with a silicon photovoltaic cell, an input amplifier, a voltage-to-frequency converter, three comparators (one in each channel), an intensity measuring channel with a signal shaper and a radiation intensity counter based on a coincidence circuit, a reference-frequency generator, and a display with decoder as well as a digital readout. The instrument operates essentially by processing the intensity-time curve and the area under it. It can be calibrated either under natural conditions or with a solar radiation simulator. The measurement error does not exceed 0.5%. Figures 2; references: 5 Russian. [490-2415]

## OPTIMIZATION OF THE CONTENT OF BASIC EQUIPMENT FOR THE HEAT CYCLE IN A THERMOELECTRIC POWER PLANT

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 5, Sep-Oct 79 pp 24-34 manuscript received 13 Dec 78

POPYRIN, L. S., KLER, A. M. and SAMUSEV, V. I., Irkutsk

[Abstract] Automatic programming of design calculations for complex technological systems, according to the SMPP-6 recently developed at the Siberian Power Institute of the USSR Academy of Sciences (Siberian Division) for realization on a BESM-6 high-speed digital computer, is not yet adequate in terms of yielding most economic solutions. This drawback can be eliminated by changing from more limited original manual design procedures to much broader ones fully utilizing the computer capabilities, especially in the area of equipment and technoeconomic indicators optimization. This is demonstrated in the case of a steam electric power plant. An appropriate program has, accordingly, been written in ALGOL-60 and successfully used for design projects at the All-Union Scientific Research and Design Institute of the Power Engineering Industry. Here the optimization of the basic equipment for the heat cycle, namely boiler and turbine staging, on the basis of steam economy is shown. The program is particularly useful for the design of highly complex heat cycles such as those in industrial heating plants. Figures 1; tables 3; references: 10 Russian. [468-2415]

## ELECTROMAGNETIC FIELD AND LOSSES IN THE ROTOR SHELLS OF A TURBOGENERATOR WITH A SUPERCONDUCTIVE FIELD WINDING

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 5, Sep-Oct 79 pp 87-92 manuscript received 19 Dec 77; after revision, 9 Jan 79

DANILEVICH, YA. B. and IVANOV, S. A., Leningrad

[Abstract] A turbogenerator with a superconductive field winding on the rotor is considered and the electromagnetic field is calculated which a rotating sinusoidal distribution of stator current density, with both space and time harmonics, induces in the rotor. The excitation winding on the rotor consists of several coaxial shells separated by vacuum layers and surrounded by a magnetic shield. The stator coils are wound on the slotless surface so that the nonmagnetic gap between stator and rotor is rather wide. With the rotor assumed to be infinitely long and the end

effect thus disregarded, the field equations are solved for the appropriate boundary conditions in a system of coordinates tied to the rotating conductor structure. The shield factor and the power loss in the field winding are then evaluated, on this basis, as functions of the shield thickness and the stator current frequency. Figures 3; references:

5 Russian.

[468-2415]

USSR

UDC 538.122:621.313.8.001.24

#### ACTIVE ZONE OF AN ELECTRIC GENERATOR WITH PERMANENT-MAGNET EXCITATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian  
No 5, Sep-Oct 79 pp 93-103 manuscript received 2 Nov 78

ZECHIKHIN, B. S., FILATOV, V. V. and TSYPKIN, V. N., Moscow

[Abstract] A multipole synchronous generator is considered with the rotor-inductor carrying permanent magnets for excitation, these magnets of a high-coercivity material and a rectangular cross section alternating between ferromagnetic tapered-section pole pieces under a yoke for maximum utilization of the active volume. The electromagnetic field within the active zone of such a generator is calculated from the field equations with appropriate boundary conditions, on the basis of the electrodynamic analog, taking into account the end effect as well as the cross magnetizing effect and the demagnetizing effect of armature reaction. Continuing this method of simulation, the magnetic fluxes in the machine and the "planar" permeances of the piecewise-uniform machine structure are computed. The results indicate that such a configuration of permanent magnets reduces both magnetic leakage and armature reaction so that paramagnetic materials can be used for the yoke. Figures 5; references: 14 Russian.  
[468-2415]

USSR

UDC 621.791.77

#### EQUIVALENT CIRCUIT DIAGRAMS FOR MAGNETIC CIRCUITS IN ELECTROMAGNETIC DEVICES

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian  
No 5, Sep-Oct 79 pp 104-113 manuscript received 20 Jul 78

LUTIDZE, SH. I., NAROVLYANSKIY, V. G. and YAKIMETS, I. V., Moscow

[Abstract] An equivalent circuit diagram is constructed for a magnetic structure with primary and secondary windings, the former connected to a voltage source and the latter connected to a load. A complete analysis



of an electromagnetic device is performed on the basis of such an equivalent circuit and the system of equations describing it, in matrix and explicit form. The general method and results are applied to devices with not only magnetically coupled but also electrically connected coils such as transformers. This procedure is particularly useful for analysis of transients such as in the case of flux switching. Figures 4; references: 3 Russian. [468-2415]

USSR

UDC 536.717.536.8:621.578

#### PERFORMANCE ANALYSIS OF A THERMOELECTRIC PLANT SIMULTANEOUSLY GENERATING ELECTRIC ENERGY AND REFRIGERATING

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 5, Sep-Oct 79 pp 114-121 manuscript received 30 May 78

CHIKOVANI, V. V., TIMASHEV, S. V. and YEVSEYEV, V. S., Leningrad

[Abstract] A new 2-stage electric power and refrigeration plant is considered which operates on Brayton-Rankine cycles with compression coupling. A gas refrigeration plant where compression during both the forward process and the reverse process occurs in the same common oversize compressor has been modified, accordingly, so that much of the reverse process occurs already while the working substance exists in two phases. This design reduces the irreversibility of heat exchange processes during the reverse part of a cycle and makes the plant performance largely independent of ambient conditions. Here the performance is analyzed on the basis of the temperature-entropy diagram and the relevant thermodynamic equations describing the various processes in a cycle: heat injection, heat extraction, adiabatic throttling, adiabatic expansion in the power turbine, and compression in the compressor. Calculations based on typical operating parameters, with the working fluid at 970 K and the target room temperature 300 K, indicate that an efficiency higher than 30% is feasible, especially with the use of radiation energy concentrators. Figures 5; references: 13 Russian. [468-2415]



## A 750 MW STEAM-GAS UTILITY TURBINE SET FOR OPERATION WITH NATURAL GAS

Moscow TEPLOENERGETIKA in Russian No 11, Nov 79 pp 6-10

CHERNETSKIY, N. S., candidate of technical sciences, OL'KHOVSKIY, G. G., candidate of technical sciences, BEREZINETS, P.A., candidate of technical sciences, KHARKIN, YU. A., engineer, BIRYUKOV, A. N., engineer, and BOREVISKIY, YE. I., engineer, All-Union Institute of Heat Engineering

[Abstract] A low-cost binary steam-gas turbine set very suitable for electric power plants using natural gas for fuel (Western Siberia, Central Asia) has been developed at the Institute of Heat Engineering. Its many advantages include a simple heat cycle, an economical performance, the possibility of further raising the temperature of the gas entering the gas turbine by adding more fuel, the possibility of increasing the total output to levels compatible with operation in gigawatt electric power plants, and easy adaptability of standard manufactured turbines as well as other equipment. Under given operating conditions the efficiency of this set increases as more of the total power is shifted to the gas turbine part of the set. The optimum steam parameters were found to be 13 MPa and 540/540°C, without regeneration. Among various schemes was selected a set consisting of two GT-150 gas turbines (ambient air +5°C, gas at turbine inlet 1100°C, separate fuel supply), a steam generator (feed water 60°C) with reheater and economizer, and one K-500-166 steam turbine with a condenser and a mixing low-pressure preheater. All these turbines are manufactured at the Leningrad Metal Plant. The set has been designed for up to 750 MW total power at 47.5% efficiency and a theoretical net fuel rate of 260 g/kWh. During the initial break-in period of operation, with gas at the inlet of the gas turbines only 940°C, the total power will be only 670 MW at a theoretical net fuel rate of 255 g/kWh. The steam generator has been designed for minimum size and maximum metal economy. A performance analysis indicates that within the 100-80% load range regulation is possible through control of additional preheat at a sliding steam pressure, without a significant increase in fuel consumption. One gas turbine can be left idle at 50-35% loads. Figures 5; tables 3; references: 1 Russian.  
[491-2415]

## A 150 MW GAS-TURBINE POWER SET

Moscow TEPLOENERGETIKA in Russian No 11, Nov 79 pp 11-17

BODROV, I. S., engineer, OGURTSOV, A. P., engineer, and REZNICHENKO, V. YA., engineer, Planning Department, Leningrad Metal Plant

[Abstract] A new 150 MW - 3000 rpm gas-turbine set has been designed and all documentation been prepared for its manufacture. This GTE-150 is based on a heat cycle with 2-stage heating of the gas at the turbine inlet, first to 900-950°C and then to 1100°C, at an air rate of 630 kg/s. The set consists of a 14-stage axial compressor (total compression ratio 13.0), a 4-stage turbine, and 14 built-in combustion chambers in annular segments spaced symmetrically relative to the shaft. The fuel rate is 48.3 tons/h, on the basis of a calorific value of 10,000 kcal/kg. Most of the design was based on data and experience pertaining to the GT-100 and other turbine sets already manufactured at the Leninrad Metal Plant. Significant modifications were made in the exhaust section, to reduce the losses and to improve the reliability. The heat cycle has been simplified so that it yields a higher heat rate and higher initial temperature, metal is used more economically and the assembly is easier. In the development, design and testing participate the Scientific-Industrial Association, the Central Institute of Boilers and Turbines, the All-Union Institute of Heat Engineering, the Central Scientific Research Institute of Machine Building Technology, the Leningrad Polytechnic Institute and the Moscow Power Engineering Institute. The performance of the GTE-150 equals that of the best similar foreign-made gas-turbine sets. It runs at a 31% efficiency. The first generation, with slightly lower performance characteristics, will be produced by 1980. The second generation, with nominal performance characteristics, should be produced by 1984-85. Figures 4; table 1.  
[491-2415]

USSR

UDC 621.643.002.2/551.481.2

CONSTRUCTION AND INSTALLATION OF PIPELINES ON ROCKY GROUND AND SWAMPLAND

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 79 pp 33-34

[Abstract] A discussion on methods of designing, constructing and installing pipelines and other surface equipment on rocky ground and swampland was held by the Organization and Technology of Trunk Pipelines Construction section of the Scientific-Technical Council to the Ministry of Construction of Petroleum and Natural Gas Enterprises, in view of the additional 23,000 km of trunk pipelines planned in the tenth five-year plan for transporting oil and gas to Western Siberia and Northernmost Regions. Discussed were the need to adapt work schedules to seasonal changes, to provide adequate special facilities for work crews in underpopulated and unpopulated areas, to coordinate with other organizations such as the All-Union Scientific Research Institute of Trunk Pipelines Construction, the Experimental Design Office for Reinforced Concrete, the Special Design and Planning Office at the Main Administration of Installation and Operations at the Ministry of the Petroleum Industry, also to cooperate with foreign enterprises, specifically Finnish firms engaged in similar activities.  
[470-2415]

USSR

UDC 621.825.7

DIAPHRAGM COUPLINGS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 79 pp 39-41

VEDMEDER, T. A., engineer

[Abstract] The range of use of diaphragm couplings is quite wide: from high power, low speed marine installations to special high speed transmissions as produced by the Bendix Corporation, operating at up to 32,000 rpm. Diagrams of the deformation of an elastic diaphragm coupling with spreading and shifting of the two coupled shafts are presented. This article is an introduction to the general principles of design of diaphragm couplings. Figures 4, References 4 Russian.  
[476-6508]

USSR

UDC 621.165.002.2

A PROMISING TECHNOLOGY OF PRODUCING BLADE BLANKS FOR STEAM TURBINES IN ATOMIC ELECTRIC POWER PLANTS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 10, Oct 79 pp 25-27

SHASTIN, E. G., engineer, KUPERMAN, D. I., engineer, PISARENKO, V. S., engineer, and MENSNIKOV, B. S., engineer

[Abstract] Blades made of various grades of chrome steel for steam turbines in atomic electric power plants are manufactured at the Leningrad Turbine Blade Works in a variety of sizes. Technologically they are classified into three groups: small-size blade blanks up to 400 mm long and weighing 1.8-8.0 kg, medium-size blade blanks up to 1000 mm long and weighing 18-44 kg, large-size blade blanks up to 1750 mm long and weighing 140 kg. Blade blanks of the first two groups are processed by forging and hot precision stamping with subsequent centerless grinding, cleaning and calibration. Blade blanks of the third group are processed by forging and hot swaging with subsequent trim cutting and trim hammering. All operations are temperature controlled and followed by full inspection as well as sample testing for mechanical properties. A promising trend of this technology is further combining of high-temperature heat treatment with mechanical precision forming in joint operations. Figures 1; tables 2; references: 2 Russian.  
[475-2415]

## FERROELASTIC COUPLINGS -- A NEW DIRECTION IN THE DEVELOPMENT OF ELECTROMAGNETIC MECHANISMS

Novocherkassk IZVESTIYA VUZov: ELEKTROMEKHANIKA in Russian No 5, May 79

PUGOVKIN, Petr Romanovich, candidate of technical sciences, docent,  
Leningrad Agricultural Institute

[Abstract] The prototype of a ferroelastic coupling is taken as an electromagnetic powder coupling of cylindrical type with one or two working gaps. The space between the working surfaces of the driving and driven parts of the coupling is filled with a ferromagnetic powder. A magnetic field acting on the powder particles can produce either rigid or sliding connection between the driving and driven parts of the coupling. Conventional electromagnetic powder couplings have the serious disadvantage that it is difficult or impossible to isolate the working gap from the inner cavities of the coupling, so that there may be a change in concentration of the ferromagnetic filler during operation with resultant alteration of the parameters and characteristics of the coupling. If the filler particles get into the bearings, the operation of the coupling can be rapidly disrupted. In the proposed design, this problem is solved by using a nonmagnetic elastic medium to bind the particles together. An investigation of the physicomachanical and magnetic properties of such a ferroelastic working substance based on silarylene siloxane elastomers and R-10 carbonly iron powder in various concentrations shows that these materials are satisfactory for the proposed purpose. The optimum concentration of filler gives a permeability of  $\mu = 6-8$ . The material is isotropic with respect to electrical, magnetic and mechanical properties. Static tests show that the specific coupling force set up in the working gap is sufficient for making drive shafint with this coupling. Figures 2, references 4 Russian.

[402-6610]

## EVALUATION OF OPTIMALITY CRITERIA FOR VIBRATION-PROOF SYSTEMS

Moscow MASHINOVEDENIYE in Russian No 6, Nov-Dec 79 pp 12-19 manuscript  
received 3 Oct 78; after revision, 23 May 79

GLUKHAREV, K. K. and KUZNETSOV, YU. P., Moscow

[Abstract] The problem of vibration isolation is considered as one of optimizing the response of a system to external actions, an example being a simple mass subject to kinematic excitation. The problem is solved

by narrowing the class of external and control actions to quasi-periodic processes and synthesizing the control in this "first approximation". The effectiveness of the solution can be evaluated on the basis of any of several optimality criteria in the phase plane, namely: maximum excursion, maximum absolute velocity, sum of both, dispersion of excursion, and dispersion of phase trajectory. Each criterion imposes requirements on the control action. Here, for illustration, the first of these criteria is considered and a control action of limited power is synthesized which will minimize it. Figures 4; table 1; references: 6 Russian.  
[489-2415]

USSR

UDC 621.752.6

#### DESIGN OF AN ACTIVE VIBRATION SUPPRESSOR WITH RELAY ACTION FOR RANDOM VIBRATIONS

Moscow MASHINOVEDENIYE in Russian No 6, Nov-Dec 79 pp 20-22 manuscript received 20 Sep 77; after revision, 9 Nov 78

INOSOV, S. V., Kiev

[Abstract] An active dynamic vibration suppressor in the form of an exciter-autocompensator is, because of its small size and weight, very suitable for vibration proofing of large structures and machinery. The device consists of an actuator mounted on the structure, a vibration transducer and a regulator. The actuator produces a thrust force which, controllable as a function of the vibration velocity, compensates vibrations of the structure due to external excitation. A relay used as the regulator offers the further advantage of optimal control, in terms of maximum rms thrust force in the case of a limited peak thrust force. Here the parameters of such a vibration suppressor are calculated which will optimize the nominal actuator thrust force and the velocity threshold of relay response. The basis of the design is reducing the level of random vibrations and thus on a statistical analysis of the latter. This design method has been applied to a vibration suppressor for the dumping boom of an excavator. Figures 2; references: 5 Russian.  
[489-2415]

USSR

UDC 621.165:621.313.322-81.043.3:62-755.001.24

CALCULATION OF BALANCING LOADS DURING MULTIPLANE BALANCING OF TURBINE ROTORS

Moscow ELEKTRICHESKIYE STANTSII in Russian No 7, Jul 79 pp 46-50

SALIMON, A. V., candidate of technical sciences and TARAKANOV, V. M., engineer, All-Union Institute of Heat Engineering

[Abstract] An analysis of the problem of balancing of flexible turbine shafts is presented. The disagreement between calculated and actual residual vibration observed in practice results primarily from the fact that the equations used do not accurately describe the oscillations of the complex system consisting of the shaft, the oil film, bearings and foundation. Rigid limitations must be placed on the mass of balancing weights in comparison to test weights. The conditions of the unit and its operation during different vibration parameter measurements must be maintained strictly identical. Figures 4, References 5 Russian. [474-6508]

USSR

UDC 621.165:62-762.004.69

IMPROVEMENT IN RIM SEALS IN THE K-300-240 TURBINE OF THE LENINGRAD METALS PLANT

Moscow ELEKTRICHESKIY STANTSII in Russian No 7, Jul 79 pp 70-72

ORLIK, V. G., candidate of technical sciences, NOVIKOV, B. B., MIKHAYLOV, S. YA. and PERMINOV, I. A., engineers, Central Institute of Boilers and Turbines, Lenenergomont, Kirishskaya Regional Electric Powerplant

[Abstract] Studies have shown that under the conditions characteristic for modern powerful turbines, rim seals with radial orientation of the sealing gaps are ineffective. This article analyzes seals with axial sealing gaps. A diagram of the redesigned rim labyrinth seal is presented. Tests of the modified seals yielded an increase in economy of 0.8%. The new type of rim seal is recommended for wide use in high temperature cylinders of high power turbines. Figures 3, References 12 Russian. [474-6508]



USSR

UDC 621.165:62-752

EXPERIENCE IN INCREASING THE VIBRATION RELIABILITY OF T-250/300-240  
TURBINES

Moscow ENERGETIK in Russian No 9, Sep 79 pp 12-13

SEREBRYANIKOV, N. I., engineer and MIKUNIS, S. I., candidate of technical sciences

[Abstract] As the T-250/300-240 turbine units were put on stream in the Moscow power system, field experiments were performed in order to improve the vibration stability of the rotor of the high pressure turbine. An extensive series of experiments was also performed to determine the influence of various types of seals on damping. In September of 1973, during a major overhaul of the first unit installed, repair personnel found significant elastic deformations of structural elements in the foundation of the turbine unit. Close cooperation of the manufacturing plant allowed the necessary redesign to be completed quickly, bringing these turbines up to nominal load with good vibration stability of the shaft drive in a short period of time.

[478-6508]

USSR

UDC 621.438:536.242

SPECIFICS OF PLANNING OF THERMAL DESIGN OF COOLING SYSTEMS OF GAS TURBINE  
BLADES WITH LONGITUDINAL CHANNELS

Moscow ENERGO MASHINOSTROYENIYE in Russian No 9, Sep 79 pp 5-7

DYBAN, YE. P., doctor of technical sciences, BILEKA, B. D., candidate of technical sciences and MEL'NIKOVA, V. A., engineer

[Abstract] A study is made of a method of thermal planning of the cooling system for blades with longitudinal channels which is applicable not only for systems with parallel movement of air exhausting into a radial gap, but also for systems with looping movement of air. The essence of the method of design consists of using the inverse problem of heat conductivity and an analog computer to determine the boundary conditions of the third kind (heat transfer coefficient) on the cooling side to satisfy the required temperature state parameters. In practice, the procedure is conducted as follows: the assigned maximum blade temperature is used to determine the possible value (or range of values) of relative mean surface temperature, considering that it is usually higher than the maximum temperature by 5 to 35%. This value is then used to select the geometric factor and the relative depth of cooling. Then the degree of nonuniformity

of distribution of temperature is determined, then the mean integral temperature through the cross section of the blade is found. This temperature is used to refine the optimal value of the geometric factor. The process is repeated until the values agree satisfactorily. Figures 3, References 3 Russian.

[476-6508]

USSR

UDC 621.154:621.822.001.24

#### SELECTION OF OPTIMAL PARAMETERS FOR SEGMENTED RADIAL STEAM TURBINE BEARINGS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 79 pp 11-13

TOKAR', I. YA., doctor of technical sciences, VISHNIVETSKIY, M. G., engineer and SIRENKO, V. A., candidate of technical sciences

[Abstract] Segmented radial bearings are becoming increasingly common in turbine building. Therefore, a mathematical study was performed in order to determine the optimal parameters of these bearings. The influence of various geometric relationships on the operating characteristics were determined by a method outlined in an earlier work. The final versions were calculated considering variations from isothermicity. The following assumptions were made, based on studies of segmented bearings 420 and 520 mm in diameter: the movement of fluid in the lubricant layer is laminar; the temperature of the oil at the entry to a segment is equal to the temperature of the oil before the bearing; calculation of statistical characteristics of a segmented bearing can be performed without considering the segments in the upper half. Based on the studies, the following parameters of segments of turbine bearings can be considered optimal: tangential eccentricity  $\xi = 10\%$ ; shape of segment grooves  $\psi = 0.0005$ ; ratio of width of segment to shaft diameter  $B/D = 0.55$ ; number of oil input areas at high pressure for hydrostatic lubrication--4. Figures 4, References 7: 5 Russian, 2 Western.

[476-6508]

USSR

UDC 621.224.004.6

#### INCREASING THE RELIABILITY OF WATER TURBINES

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 79 pp 22-24

GAL'PERIN, M. I., KIRILLOVA, M. P., SHRIRO, I. I., engineers and PYLAYEV, N. I., candidate of technical sciences

[Abstract] Late in 1978, Soviet power engineers gathered three times to discuss various aspects of the operational reliability of water turbines.

A meeting in Moscow of the water turbine section of the Scientific and Technical Council of the Ministry for Power Machine Building studied the reliability of the sealing devices of variable-pitch runners and shafts in water turbines. A conference in Bratsk of the hydromechanical section of the Central Administration of the Scientific and Technical Society for Power Engineering and the Electric Engineering Industry analyzed problems of cavitation of operating turbines and increases in erosion resistance of turbines currently produced. At Chirchik, a school of leading experience in the operation of turbine hydroelectric powerplant equipment was organized by the Pavilion "Electrification of the USSR" of the Exhibition of Achievements of the National Economy. Subjects discussed at these three meetings included: permanent seals, tracking-type end seals, removable collar type seals, electrode surfacing for improved cavitation resistance, input of air to the cavitation zone in a turbine and updating of equipment for improved cavitation resistance and operational characteristics. References 6 Russian.  
[476-6508]

#### USSR

#### DISCUSSION OF THE TECHNICAL PLAN FOR HEAT SUPPLY OF THE TK-450/500 STEAM TURBINE FOR THE POWER UNIT OF A NUCLEAR HEAT AND ELECTRIC POWERPLANT

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 79 pp 44-45

[Abstract] The Scientific and Technical Council of the Ministry of Power Machinery has analyzed a technical plan for a type TK-450/500 steam turbine for the power units of a nuclear heat and electric powerplant, made in accordance with a technical assignment for development and a resolution of the council for the production of a rough plan for the TK-450/500-60 turbine. The turbine is to operate in combination with the VVER-1000 water/water reactor (2 turbines per power unit), the VVER-500 reactor and the VK-500 reactor in a 2-loop system. The plans were standardized as much as possible, both in the turbines themselves and in the associated equipment. The turbine is a single shaft, 4 cylinder unit with choke steam distribution. The council has rated the plans developed to date quite highly in terms of quality.  
[476-6508]

## WELDED-FORGED TURBINE RUNNERS FOR ATOMIC AND THERMAL POWER PLANTS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 10, Oct 79 pp 22-25

RUDKOVSKIY, A. F., chief director of Planning Department, "Kharkov Turbine Plant" GERMAN, S. I., candidate in technical sciences

[Abstract] The welded-forged construction of turbine runners for atomic power plants offers many metallurgical and technological advantages over the conventional integrally forged and shrunk-on constructions. It furthermore improves certain service characteristics with a lower stress concentration due to absence of a center hole and a random rather than oriented stress distribution due to heating, also making replacement of defective sections more easy and economical. Such turbine runners are already installed and operating in the low-pressure turbine stages of some large power plants in the Soviet Union and abroad. The welded-forged construction requires special assembly techniques. Vertical stacking and automatic welding poses no problems in the case of smaller runners weighing up to 40 metric tons, but in the case of larger runners weighing up to 200 metric tons there can occur a misalignment of disks or bending of the axis upon dropping to the horizontal position after assembly. An assembly method has been developed at the Kharkov Turbine Plant to avoid this problem, namely by horizontal stacking and welding with the disks separated by prismatic spacer bars in a "biscuit" fashion and with special heat treatment during and after welding. Runners weighing up to 250 tons, 2500 mm in diameter and 13,000 mm long, can be assembled by this method for subsequent installation in power turbines as large as 1200 MW, not only in low-pressure but also medium-pressure and high-pressure stages. Figures 2; tables 3. [475-2415]

USSR

UDC 531.383

PROCEDURE FOR ADJUSTMENT OF A GYRO HORIZON COMPASS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian  
No 5, 1979 pp 19-23 manuscript received 24 Nov 77

AGAFONOV, S. A. and SHUL'MAN, I. SH., Moscow

[Abstract] The known method for stabilizing a gyroscopic inertial platform in the horizontal plane and along the meridian line of the locus is compared with its variant utilizing extraneous information on the rate of motion of the object and the latitude of its locus, with the object of damping the oscillations of the platform relative to the horizontal plane. Sufficient conditions for the asymptotic stability of the equilibrium position of the platform along the meridian line with respect to the geographic triangle xyz (with the z-axis directed along the Earth's radius, the y-axis lying in the meridian plane, xy-axis tangential to the terrestrial sphere) are derived with the aid of the Lyapunov function. References 7 Russian.  
[487-1386]

USSR

UDC 531.383

SELECTION OF SIGNAL MEASUREMENT TIME IN A GYRO-OPTICAL COMPASS

Leningrad PRIBOROSTROYENIYE in Russian Vol 22 No 6, Jun 79 pp 64-68  
manuscript received 28 Feb 78

SEREGIN, V. V., Leningrad Institute of Precision Mechanics and Optics

[Abstract] When a laser gyroscope is used to solve the problem of gyrocompassing, digital methods must be employed to measure with high accuracy the beat frequency of the laser gyroscope's output signal. The output signal must be converted into a pulse train, i.e., the signal must be quantized in terms of level, as the result of which a quantizing error is evidenced. The operating principle of digital freq-meters used to measure beat frequencies in gyrocompassing necessitates a relatively long measuring time. The speed of response is an important characteristic of any gyrocompassing system. In this study equations are derived which relate the one-time signal measurement time and the errors of the laser gyroscope which are decisive in a specific compass system. The speed of response of the gyrocompassing system is regarded in relationship to gyrocompassing accuracy, which is governed both by the design of the gyro-optical compass and the algorithm for calculating the bearing. Taken into account are the additive errors introduced by the laser gyroscope itself and errors in



measuring its output signal. It is assumed that the laser gyroscope is installed on a base which is immobile in relation to the earth and that this base has been leveled with ideal precision. Equations are found for the error in computing the bearing angle resulting from the influence of zero drift and the quantizing error. An expression governing the choice of signal measurement time is derived by substituting these equations in an equation for a test for a negligible error. This test is in the form of a condition whereby the quantizing error can be disregarded in comparison with the error resulting from zero drift. An equation is presented for the error in gyrocompassing resulting from zero drift and signal quantization, which defines the maximum permissible error with the ideal filtration of fluctuations in the output signal of the laser gyroscope. It is concluded that the problem of optimizing the speed of response of a gyro-optical compass operating on an immobile base must be solved by taking into account a model of the laser gyroscope's error and the algorithm for processing its output signal in a specific compass design. A calculation example is given, employing the equations derived. References 8 Russian.

USSR

UDC 531.383

#### INVESTIGATION OF A FLOATING SENSING ELEMENT WITH PULSED FEEDBACK

Leningrad PRIBOROSTROYENIYE in Russian Vol 22 No 6, Jun 79 pp 68-72  
manuscript received 18 Apr 78

BARANOVSKIY, V. N. and UFIMTSEV, S. A., Chelyabinsk Polytechnical Institute  
imeni the Leninist Komsomol

[Abstract] Pulsed feedback is presently extensively used in floating sensing elements in navigational gyroscope systems. Pulsed feedback has the advantages over analog feedback of high noise rejection and a convenient form of signal for processing with digital integrators. In this paper a solution is given to the problem of finding algorithms for and methods of studying the behavior of sensing elements with pulsed feedback when the pulsed effects are functions of generalized coordinates of the system. It is demonstrated theoretically that proportional pulsed feedback for two-frame gyroscopes, unlike analog feedback, does not introduce errors in their readings. The feedback is called proportional because the amplitude of pulses is proportional to the number of the level and a pulse originates at the moment when the sensing element's output spindle passes the boundary of the  $n$ -th level. Two cases are considered: that of heavy damping and relatively low gain in the pulsed feedback circuit, and that of high gain in the pulsed feedback circuit. It is shown that the two-level floating sensing element considered operates in the integrating mode, with heavy damping and relatively low gain in the pulsed feedback

circuit, just like an instrument with analog proportional feedback. Just as for the operating mode of an integrating gyroscope, the pulsed nature of the feedback has almost no effect on the behavior of the sensing element; vibrations rapidly attenuate. References 6 Russian.

USSR

UDC 531.383

# ESTIMATION OF THE TORQUE ACTING ON THE TRUNCATED ROTOR OF A GYROSCOPE WITH AN ELECTROSTATIC SUSPENSION DUE TO THE EDGE EFFECT

Leningrad PRIBOROSTROYENIYE in Russian Vol 22 No 6, Jun 79 pp 73-76  
manuscript received 28 Feb 78

PEVZNER, A. YE., OSIPOV, YU. M. and PEVZNER, YE. M., Leningrad Institute of Precision Mechanics and Optics

[Abstract] The edge effect in the electrodes is one of the factors determining the working accuracy of a gyroscope with an electrostatic suspension. Calculation of the edge effect of the torque caused by it and acting on the rotor involves solving a complex boundary value problem relating to calculation of the electrostatic field. This is a mathematically complicated problem whose solution is not always justified inasmuch as the edge effect itself has but a slight effect on the gyroscope's operation. A description is given of an approximation procedure for calculating the edge effect in order to provide an estimate of its magnitude. The problem is solved for the normal position of the rotor, when the gap in the electrode is in line with the circular area on the rotor intended for picking up information. The following assumptions are made: 1) The edge effect is taken into account by the accumulation of an additional charge at the edges of the electrodes and is calculated by the familiar method employing the system of an infinite plane and a plate of finite length. This assumption is justified because of the fact that the actual charge concentrated on the circumference of the groove in the electrodes and resulting from the edge effect differs little from the charge introduced in the calculation, since the size of the gap is much smaller than the radius of the rotor and the radius of the groove. This makes it possible for the spherical surfaces to be regarded as planes and the arcs of circles as straight lines. 2) The plane problem is considered, i.e., the size of the gap is much smaller than the radius of the rotor. 3) The mutual influence of the electrodes is disregarded. 4) The calculation system employed considers an infinitely thin ring with an evenly distributed linear charge density equal to the density of the added charge, the ring being under the conducting plane. When the charge in an electrode interacts with induced charges on the surface of the rotor the maximum torque is observed when one electrode is under voltage and the other is not, in other words, when just the half-ring is charged. The force acting on this



half-ring is assumed to be half the force acting on the entire ring. A determination is made of the force acting on the ring with a specific difference in potential between the ring and the plane. For this the mirror reflection method is used with calculation of the force acting between two identical rings with opposite charges and spaced twice the distance of the electrode gap apart. The approximate solution arrived at produces values which agree closely with the exact calculation of the torque by solution of the boundary value problem. Figures 4; references 3 Russian.

USSR

UDC 621.375.826

A PULSE SOURCE OF LASER RADIATION ENERGY

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 11, Nov 79 pp 36-37

YELAGIN, A. YU., VASIL'YEV, YU. S., ROMASHKOV, A. P., ULANOVSKIY, M. V.  
and KHAYKIN, N. SH.

[Abstract] A pulse source of laser radiation energy as a measurement standard has been built which consists of a single-mode one-frequency highly stable 1.0 W continuous-wave CO<sub>2</sub> laser ( $\lambda = 10.6\mu\text{m}$ ), an optical system, an optomechanical chopping shutter with a motor-driven tape transport mechanism, and an auxiliary He-Ne laser with an electron-optical converter for recording and measuring of the energy pulses. The main laser has a relative power instability not exceeding 0.7% and a relative frequency instability within  $10^{-7}$ - $10^{-8}$ . The laser beam is polarized linearly and vertically, its divergence not exceeding 3 mrad and its power density distribution being nearly normal. Figures 2.  
[497-2415]

USSR

UDC 681.7.065.454

OPERATIONAL CHARACTERISTICS OF ONE-LAYER VACUUM ANTIREFLECTION COATINGS FOR THE NEAR INFRARED AREA OF THE SPECTRUM

Moscow OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 5, 1979  
pp 42-44 manuscript received 23 May 78

GISIN, M. A., AMIROV, I. A., VLADIMIROVA, I. S., ZAVADA, L. S., and  
MUSTAYEV, R. M.

[Abstract] Results are presented from studies of the variation of the operating characteristics of antireflection-treated specimens with sputtering of coating materials. All experiments were performed on a vacuum installation which allowed planetary rotation of the substrates, testing of the thickness of the coating during sputtering and heating of the substrates. Coatings tested included silicon monoxide, zinc sulfide, arsenic sulfide and a mixture of zinc sulfide and cerium fluoride. Due to the technological simplicity of the process, arsenic sulfide is considered preferable to the other materials in the shortwave region of the spectrum if the optical element will not be heated to over 150°C. Figures 2, References 5: 3 Russian, 2 Western.  
[427-6508]

## AN OPTICAL FILTER WITH A SPIRAL GRATING

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 7, Jul 79  
pp 53-54 manuscript received 22 Jun 78

POLUSHKIN, YU. I., DENISOV, L. M., POMINA, T. N. and STANEVICH, A. YE.

[Abstract] A reflecting optical filter has been developed which features all favorable characteristics of an echelette filter and, furthermore, does not polarize the light. Its reflecting surface, one side of a brass or duralumin disk, has a single groove cut on a screw lathe with transverse feed in the form of a spiral running symmetrically from the periphery to the center and back to the periphery. Its spectral characteristics depend strongly on the cutter rake angle and on the groove depth. Such a spiral grating with a 0.2 mm pitch, cut at a rake angle of 140-150°, was checked out against a comparable echelette grating with 4 lines/mm and a 12° "glare" angle. Its infrared reflection spectrum has been found to be as narrow in the case of unpolarized incident light and even narrower in the case of arbitrarily polarized incident light. Figures 2; references 7: 3 Russian, 4 Western.  
[467-2415]

## ANOMALIES CHARACTERIZING THE EFFECT OF LOW-ABSORPTION LAYERS ON THE REFLECTION COEFFICIENT OF QUARTER-WAVELENGTH MIRRORS IN OBLIQUELY INCIDENT LIGHT

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian, No 7, Jul 79  
pp 54-55 manuscript received 17 Feb 78

MINKOV, I. M., VEREMEY, V. V. and GORBUNOVA, T. A.

[Abstract] Two basic kinds of quarter-wavelength mirrors are considered:  $S(HL)^kHA$  or  $S(LH)^kA$  and  $S(HL)^kA$  or  $S(LH)^kLA$ , where  $S$  denotes a substrate,  $H$  and  $L$  denote layers with a respectively high and low refractive index,  $k$  denotes the number of such layers, and  $A$  denotes air. The relative magnitudes of the refractive index of all practical real materials are  $n_H > n_S > n_L > n_A$ . The performance of these mirrors in obliquely incident light is analyzed, assuming that the wavelength of incident light coincides with the center wavelength of the high-reflection band of such a mirror. The effect of low-absorption layers is shown to be a suppression of either normal or parallel reflection and thus the feasibility of modulating the difference  $R_{\perp} - R_{\parallel}$  between the two respective reflection coefficients. Figures 2; references 7: 3 Russian, 4 Western.  
[467-2415]

## A STABILIZED WIDEBAND PHOTOAMPLIFIER

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian, No 7, Jul 79  
p 60 manuscript received 10 Mar 78

SEBKO, S. YE. and KLIMASHIN, V. P.

[Abstract] A wideband photoamplifier has been designed which consists of two capacitor-coupled stages with local feedback each, to ensure stability. The amplifier is preceded by a diode photodetector feeding electric signals to an emitter follower first. The latter includes an MOS transistor and a bipolar transistor, while the subsequent amplifier stages are built with bipolar npn and pnp transistors. The gain can be regulated from  $25 \pm 10\%$  to  $100 \pm 10\%$  by means of variable resistors, without a change in the feedback factor. An extra resistive-capacitive feedback is provided for high-frequency compensation, extending the frequency range of the amplifier to 50 MHz. The photodetector bandwidth is determined by a load resistance. The device draws not more than 40 mA  $\pm 10\%$  from a stabilized +12.6 V d.c. voltage supply. The gain remains stable within 8% during temperature fluctuations from -50 to +50°C and  $\pm 20\%$  supply voltage fluctuations. Figure 1; references: 2 Russian.  
[467-2415]

## A BETATRON WITH MAGNETIZATION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 pp 27-29  
manuscript received 6 Apr 78

VASIL'EV, V. V., MOSKALEV, V. A. and FURMAN, E. G.

[Abstract] A description is presented of a betatron with magnetization using a new system which does not suffer from the defects of previous systems: essential instability of the position of the equilibrium orbit during the acceleration cycle, difficulty in adjustment and in operation. The required distribution of magnetic fluxes in the pole gap is achieved by compensation shielding of the winding located in the slots around the central continuous core of the electromagnet and loaded inductively. Operational testing has shown high reliability of the installation and convenience of adjustment. Figures 3, References 4: 2 Russian, 2 Western.  
[471-6508]

USSR

UDC 621.3.032.266.001.5

**EXPERIMENTS ON RECOVERY OF ENERGY OF A MONOENERGETIC ELECTRON BEAM IN A COLLECTOR OF A SPECIAL CONFIGURATION**

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 pp 29-32  
manuscript received 5 Nov 77; final version 17 Jan 78

DIMITROV, S. K., LUTS'KO, A. S., and MIKHIN, S. G., Moscow Institute of Engineering and Physics

[Abstract] A description is presented of recovery of the energy of a beam of electron in a system in which the beam is divided in the collection zone which consists of three electrodes. Preliminary experiments were performed to study the properties of this type of collector. A formed and collimated beam of electron enters the deceleration field between two electrodes. Secondary electrons entering the deceleration region, as well as electrons reflected from areas with high space charge density, are accelerated in the direction opposite to the movement of the beam and collected on one of the two electrodes. The effectiveness of recovery of energy is calculated. The maximum recovery effectiveness is achieved at a certain depth of deceleration of the beam of about 95%. Figures 4, References 3 Russian.  
[471-6508]

USSR

UDC 621.384.62

**A PROTON BEAM SOURCE**

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 pp 33-36  
manuscript received 9 Mar 78

AUSLENDER, V. L., LAZAREV, V. N. and PANFILOV, A. D., Institute of Nuclear Physics, Siberian Affiliate, USSR Academy of Sciences

[Abstract] A pulsed proton source is described which is used in a 1.5 MeV accelerator serving as an injector for the B-5 200 MeV proton synchrotron. A cold cathode source with oscillation of electrons in a magnetic field was used because of the design and simplicity, long service life and increase in the content of atomic ions of hydrogen in the beam thus achieved. A diagram of the source is presented. Graphs and a beam image on an aluminum foil target at a distance of 240 mm from the center of the electrode of the lens are used to illustrate the characteristics of the beam. Figures 3, References 10: 7 Russian, 3 Western.  
[471-6508]

## IMPULSE DESORPTION OF A SLIT CATHODE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 pp 36-39  
manuscript received 27 Feb 78

DANIL'TSEV, YE. N. and PERSHIN, V. I.

[Abstract] A study is made of a cathode used to produce a powerful electron beam in which the plasma is generated by a pulse of voltage over the complex lateral surface of a dielectric oriented parallel to the field. The plasma is formed of gas desorbed from the dielectric. A cross-sectional diagram of the diode is presented. The cathode consists of a collection of dielectric plates alternating with metal plates, which are recessed with respect to the edges of the dielectric plates. The mechanism of operation of the cathode is explained. A flat glass cathode measuring  $11 \times 8.5 \text{ mm}^2$  has achieved a perveance of  $20 \cdot 10^{-6}$ . Figures 3, References 8: 4 Russian, 4 Western.  
[471-6508]

## NEUTRON GUNS OF THE SYNCHROCYCLOTRON OF THE LENINGRAD INSTITUTE OF NUCLEAR PHYSICS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 pp 44-46  
manuscript received 15 Mar 78

BATURIN, V. N., KOPTEV, V. P., MAYEV, YE. M., MAKAROV, M. M., HELYUBIN, V. V., SULIMOV, V. V., KHANZADEYEV, A. V. and SHCHERBAKOV, G. V., Leningrad Institute of Nuclear Physics

[Abstract] The neutron gun of the LINP synchrocyclotron is described. A proton beam leaving the synchrocyclotron is focused by quadrupole lenses onto a neutron-forming target in a spot 2.5 cm in diameter. The target is placed at the entry to the chamber of a rotary magnet. The neutrons leaving the target pass the ray collimator and enter the experimental chamber after further filtering with two double lenses. As the atomic number of the target material increases, the flux of neutral particles increases. Figures 4, References 2: 1 Russian, 1 Western.  
[471-6508]



A 90-CHANNEL CHERENKOV MASS SPECTROMETER FOR HIGH ENERGY GAMMA QUANTA AND ELECTRONS (THE "PHOTON" INSTALLATION)

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 pp 57-67  
manuscript received 17 Apr 78

AVERICHEV, S. A., ARKHIPOV, V. V., ASTVATSATUROV, R. G., BAKAYEV, V. V.,  
BALDIN, A. M., BASILADZE, S. G., BOYTSOVA, L. S., GOLOBANOV, L. B.,  
ZANEVSKIY, YU. V., IVANOV, A. B., IVANOV, V. I., IVANCHENKO, I. M.,  
KIRILLOV, A. D., KNAPIK, YE., KOLPAKOV, I. F., KRAMERENKO, V. A.,  
KULAKOV, B. A., KULIKOV, YU. V., KURYATNIKOV, B. K., MAKAROV, L. G.,  
MALAKHOV, A. I., MATYUSHCHEVSKIY, YE. A., MAZARSKIY, V. L., MELKUMOV, G. L.,  
MOYSENZ, TS. V., PARSHUTOV, V. T., PESHEKHONOV, V. D., PLYASHKEVICH, N. N.,  
PLYASHKEVICH, S. N., SENNER, A. YE., SMIRNOV, V. A., STARCHENKO, B. M.,  
TROFIMOV, V. T., KHACHATURYAN, M. N., TSVINEV, A. P., CHVYROV, A. S.,  
CHERNENKO, S. P. and FIRKOVSKI, R., Joint Institute Nuclear Research, Dubna

[Abstract] A Cherenkov lead-glass mass spectrometer has been produced for experimental search for new resonances in  $e^+e^-$ ,  $2\gamma$ ,  $3\gamma$  and other systems on the 70 GeV synchrotron at Serpukhov. The principle of measurement of effective masses of electron-positron pairs and gamma quanta is described. A diagram of the mass spectrometer is presented. The basic elements of the mass spectrometer are listed. Calibration and adjustment of the device for maintenance of stability of gamma spectrometers are described. A diagram of the liquid hydrogen target is presented. The computer software used to run the installation is briefly described. The basic parameters of the mass spectrometer are noted. Figures 9, References 26 Russian.

[471-6508]

A WIDE-BAND MAGNETIC ANALYZER FOR THE PRODUCTS OF REACTIONS IN BEAMS OF HEAVY IONS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 pp 68-72  
manuscript received 4 Apr 78

[Abstract] The best method of analysis and identification of reaction products in a beam of heavy ions is a combination of direct methods of selective spectrometry, combining precision analysis of charged products of nuclear reactions in electric or magnetic fields and measurement of the speeds of products on the basis of the time required to travel a measured path or measurement of the energy of products and their specific ionization losses. A wide-band magnetic analyzer with stepped poles was



used to separate the products of nuclear reactions with heavy ions. The analyzer is described and its calibration with a beam of multiply charged ions is reported. A diagram of the experimental installation for calibration of the magnetic analyzer is presented. Figures 5, References 14: 3 Russian, 11 Western.  
[471-6508]

USSR

UDC 778:53

# HIGH SPEED CAMERAS OF THE FIVE METER MAGNETIC SPARK CHAMBER AT THE JOINT INSTITUTE FOR NUCLEAR RESEARCH

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 73-75 manuscript received 26 Nov 77

ANDREYEV, YE. M., APARIN, V. I., VASILEVSKIY, I. M., VASILENKO, A. T., ZHENCHIKOVICH, Z., KRAKHOTIN, N. D., MOISEYENKO, V. A., RYBAKOV, V. L., TOLSTOY, N. S., Joint Institute for Nuclear Research, Dubna

[Abstract] Two high speed cameras capable of operating in the start-stop mode with nonperforated 35-mm film based on lavsan or triacetate have been developed for the five meter magnetic spark spectrometer of the JINR. The frame size is 180 by 32 mm<sup>2</sup>, maximum number of operating cycles--10 frames, maximum frame shift time 50 ms, accuracy of frame positioning  $\pm 1$  mm. A cross-sectional diagram of the apparatus is presented. The use of a non-impact single-rotation mechanism with film motion stopped according to a predetermined rule of change of angular velocity of the drum eases the dynamics of operation of the mechanism, reducing the force on the film to not over 700 g. The cycle of rapid film advance is described. Figures 2, References 2 Russian.  
[471-6508]

USSR

UDC 539.1.074.22

# A LIQUID-ARGON CYLINDRICAL PULSE IONIZATION CHAMBER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 75-78 manuscript received 17 Mar 78

BARABASH, A. S., GOLUBEV, A. A., KAZACHENKO, O. V. and OVCHINNIKOV, B. M., Institute of Nuclear Research, USSR Academy of Sciences

[Abstract] For the purpose of detailed study of the operation of liquid argon ionization chambers, a chamber was created with a usable volume of 200 cm<sup>3</sup>. The anode of the chamber was made of stainless steel in the

form of a hollow cylinder. The shielding grid of the chamber was wound with beryllium wire, with a gap between the grid and the anode of 3 mm. The cathode of the chamber was a thin cylinder of brass with an inside diameter of 56 mm, cathode-grid spacing 10 mm. The results indicate that further improvement of the resolution of this type of chamber will require that the noise level of the preamplifier be reduced by a factor of 3 by cooling the FET, the influence of wall effects can be decreased by increasing the operating gap in the chamber, which will also decrease the influence of radiation losses; a flat geometry should be used, with precise compensation of nonshielding effects and absorption of ionization electrons. A thin input window for gamma quanta should be used with a reduced grid-anode gap. Figures 4, References 15: 10 Russian, 5 Western.  
[471-6508]

USSR

UDC 539.1.073/074

#### WIDE-GAP SPARK CHAMBERS OF THE TSKHRA-TSKARO LABORATORY

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 79-81 manuscript received 15 Mar 78

GROMOV, YU. A., KOTLYAREVSKIY, D. M., KANANOV, S. D., MATSABERIDZE, V. G., MOROZOV, I. V., METREVELI, T. B., RAPPOPORT, V. M., TAGLANOV, M. M., TSOMAYA, P. V., SHARABIDZE, T. I. and SHTEMANETIAN, G. Z., Institute of Physics Georgian SSR Academy of Sciences, Tbilis

[Abstract] One of the primary units used in the new installation for recording of cosmic rays at the TSKHRA-TSKARO Laboratory imeni G. Ye. Chikovani is a magnetic spark chamber measuring 140 X 150 X 20 cm<sup>3</sup>. A picture of the spark chamber is presented. All units are made separately and then glued together with epoxy resin. The sequence of assembly is described. A number of properties of the chamber distinguish it from previously known wide-gap chambers. The characteristics of the spark chamber are as follows: the operating voltage is 4 kV/cm; mean square track deflection 0.17 mm; maximum angle of tracing of sparks relative to a perpendicular to the electrodes 45°; error in determination of angle for angles near vertical 1 mrad; efficiency of recording of large number of tracks approximately 1 for  $n \leq 50$ . Figure 1, References 3: 2 Russian, 1 Western.  
[471-6508]

USSR

UDC 539.28.078

A THREE CHANNEL RECEIVER FOR FAR INFRARED RADIATION BASED ON COOLED Si:B-, Ge:B-, n-GaAs PHOTORESISTORS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 222-225 manuscript received 11 May 78

LAZAREV, V. B. and TISHCHENKO, E. A., Institute of Physics Problems, USSR Academy of Sciences, Moscow

[Abstract] This work describes a three channel detector based on Si:B, Ge:B and n-GaAs for the 15-450  $\mu$ m range. A diagram of the optical section of the cryostat is presented, showing the location of the detectors and three amplifiers. The optical unit consists of an integrating chamber on a helium cold conductor, a conical light guide, a filter window at helium temperature made in the form of a slit  $1 \times 10 \text{ mm}^2$ , another filter window in a nitrogen screen and a vacuum-tight window. Windows are made of 1 mm thick polyethylene. The integrating chamber is an optically polished hemisphere 5 mm in radius. A three channel receiver of this type is currently in use for active and passive submillimeter diagnosis of plasmas. Figures 3, References 9: 7 Russian, 2 Western.  
[471-6508]

USSR

UDC 621.318.3:621.375.826

AN ELECTROMAGNETIC SYSTEM FOR CONTROL OF THE ANGULAR POSITION OF THE OPTICAL ELEMENTS OF LASERS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 230-233 manuscript received 14 Mar 78

ZAIIA, V. V. and KOVAL'CHUK, S. V., Institute of Physics, Ukrainian Academy of Sciences, Kiev

[Abstract] This article described a sweep device in which the tunable element is rotated by an electromagnet. The tunable element is a total internal reflection prism attached to a rotating stage mounted on ball bearings. A photograph of the device is presented. The delay time required for the prism to accelerate from 0 velocity to the required stable velocity is analyzed. The variation in speed of rotation of the prism as a function of time is graphed, and typical pictures of the time variation of sweep laser intensity are presented. Figures 3, References 5 Russian.  
[471-6508]

## A LATERAL CATHODE FOR A POWERFUL ARGON LASER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 233-234 manuscript received 17 Feb 78

[Abstract] A laser is described which consists of cathode and anode units and a high current discharge tube, yielding powerful radiation on a number of lines in the blue-green region of the spectrum. A cross-sectional diagram and description are presented of the cathode unit of the laser. The emitter of the arc discharge is a hollow cathode. Since the cathode is located to one side of the tube, the service life of mirrors and other elements of the optical resonator is greatly increased, since the metal vapor remains primarily in the cathode cavity. Two models of laser with discharge lengths of 210 and 150 cm were tested. In the first model, the radiated output power was 200 W, limited by the surface quality of the mirror. A laser with a side cathode of this type has operated for more than 500 hours, after which disassembly showed no changes, the surfaces of the optical elements of the resonator remaining clean. Figures 2, References 5: 4 Russian, 1 Western.  
[471-6508]

## INCREASING THE RELIABILITY OF OPERATION OF THE AUTOMATIC CONTROL SECTION OF THE LG-32 LASER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 235-236 manuscript received 15 Mar 78

TARASYK, V. G. and KHANOV, V. A., Institute of Automation and Electronics, Siberian Affiliate, USSR Academy of Sciences, Novosibirsk

[Abstract] In standard LG-32 He + Ne lasers, the radiation frequency is stabilized using an automation unit type BP-2, an optimizing controller with periodic search signal. This article describes improvements to the automatic control unit. Schematic diagrams of the matching amplifier and time relay are presented. Figures 2, References 3 Russian.  
[471-6508]

## A Cu LASER CELL EXCITED BY A TRANSVERSE DISCHARGE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 274-276 manuscript received 20 Mar 78

BUZHINSKIY, O. I., KRYSANOV, S. I. and SLIVITSKIY, A. A.

[Abstract] The design is described of a cuvette with improved screen insulation and homogeneous temperature field in the discharge plasma. Thermal design of the cuvette was performed for a temperature of the resistive heater of 1500°C, degree of blackness 0.8, for insulation of molybdenum foil of rectangular profile with degree of blackness 0.2, assuming the temperature of the body of the cuvette to be 30°C. A cross-sectional drawing of the cuvette is presented. The variation of the temperature of resistive heating and shield insulation with time are calculated for molybdenum shields and combined insulation. Lasing starts when the temperature on the electrodes reaches 1200°C, the mean power increasing smoothly with increasing temperatures. Figures 3, References 2 Russian.  
[471-6508]

USSR

UDC 621.313.322-81.043.2.017.71.001.24

STUDY OF HEATING OF THE END VANE ASSEMBLY OF THE STATOR CORE OF A TURBINE GENERATOR

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 79 pp 31-34

FEDORENKO, G. M., candidate of technical sciences, VYGORVSKIY, V. I. and BUT, A. A., engineers, Institute of Electrodynamics, Academy of Sciences, Ukrainian SSR

[Abstract] The purposes of this article include: development of a mathematical model for prediction of the stable heat regime of the end group of blades on a stator core; determination of local and integral heat losses in these blades; variational analysis of the temperature field of these blades; and search for the most desirable areas for intensification of cooling to achieve a more modern design. Experimentally determined temperature fields are diagrammed. The mathematical model developed allows the effectiveness of measures designed to intensify cooling to be judged with accuracy sufficient for practice. The model can be used at repair enterprises, scientific research and planning institutes. Figures 2, References 6 Russian.  
[473-6508]

USSR

UDC 621.313.333-71.001.24

EFFECT OF INTERNAL HEAT TRANSFER ON THE THERMAL STATE OF TOTALLY ENCLOSED LOW-POWER ELECTRIC MOTORS

Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 79 pp 29-31 manuscript received 13 Jul 78

KOSTIKOV, O. N., candidate of technical sciences, MALYKHIN, YE. I., engineer, US, Z. P., engineer, and YAKOVLEV, A. I., candidate of technical sciences

[Abstract] A computer study was made of heating inside totally enclosed small 4-pole induction motors, for the purpose of evaluating the relative effectiveness of various methods of reducing it. The temperature rise in the stator end winding on the opposite side of the shaft extension and the temperature rise in the bearing assemblies were calculated on a BESM-4M high-speed computer on the basis of the equivalent thermal circuit. The thus established dependence of these temperature rises on such variables as the endshield surface area, the rotor blading area, various heat transfer coefficients, the rate of air circulation, the thickness of slot insulation, and the thermal conductivity of individual components of the insulation system reveals that conventional methods are not very effective



and involve tradeoffs. The most drastic way to reduce internal heating of such a motor, after all the external cooling capacity has been utilized, is to completely impregnate the stator winding with compounds of high thermal conductivity and to facilitate an evaporation-condensation process cycle or closed-loop direct heat transmission from stator winding and rotor cage to ambient air. These conclusions are based on data for model 4AA71B4 and model 4AA100L4 induction motors with the shaft height 71 mm and 100 mm respectively above the mounting base. Figures 5; references: 3 Russian. [466-2415]

USSR

UDC 533.6.01:51:621.165

**CALCULATION OF THE AXISYMMETRIC FLOW PATTERN IN AXIAL TURBINE STAGES OPERATING UNDER BASE AND PARTIAL LOADS**

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 5, Sep-Oct 79 pp 148-155 manuscript received 23 Jun 76; after revision, 20 Mar 79

TOPUNOV, A. M., YEGOROV, V. V., POGODIN, YU. M. and TIKHOMIROV, B. A., Leningrad

[Abstract] In order to determine and avoid flow separation in the design of axial turbine stages with long and either broad or sweptback blades, it is necessary to calculate the axisymmetric flow pattern throughout the cascade on the basis of a model more intricate than that of a cylindrical stream. Here the model of a jet stream serves as the basis of such calculations for a turbine operating under base or reduced load. The fundamental equations are those of an elliptical boundary-value problem for a nonisentropic and nonisenthalpic flow of a nonviscous compressible fluid. They are solved by a numerical method involving integral relations and smooth approximating functions which reduce the original two-dimensional problem to a 2-point problem with second-order ordinary differential equations. This method has been successfully applied to subsonic axisymmetric flow in turbine stages of various configurations operating in the nominal mode or inefficiently as, for instance, with flow separation. The results of calculation correlated with experimental data are useful for predicting flow variations and transitions, particularly the instant at which separation will occur. Figures 4; references 11 Russian. [468-2415]



**THE EFFECT OF THE BASE REGION ON SUPERSONIC FLOW PAST A CONE WITH POWER-LAW INJECTION**

Kiev PRIKLAADNAYA MEKhanika in Russian Vol 15 No 8, Aug 79 pp 99-103  
manuscript received 3 Nov 77

ANTONOV, A. M. and ZAKREVSKIY, V. A., Kiev State University and Kiev Institute of Civil Aviation Engineers

[Abstract] Axially symmetric supersonic flow around a finite cone is discussed for the case in which the mass flow of gas through the porous surface is subject to power-law relationship. A thin surface layer much thinner than the length of the body but larger than the Prandtl boundary layer is considered. The pressure distribution along the body is governed by the thickness distribution of the injected gas layer, which in turn depends on the way in which the pressure varies. Since in such flows a disturbance can be propagated upstream, the conditions on the base area affect the flow from the nose onward. The procedure of V. Ya. Neyland is used to treat the differential equations describing the situation; the second approximation is worked out numerically by computer and graphs and tables of the main parameters are presented. The solutions for the finite cone, in contrast to the semiinfinite cone, have additional terms added to the first terms of the power series to allow for the effects of the base cross section. An expression giving the approximate size of the area outside of which the effect of the finite dimensions is decisive is derived. Thanks are expressed to V. Ya. Neyland. Figures 3, References 5: 4 Russian, 1 Western.

**DIFFRACTION OF A SURFACE GRAVITY WAVE BY SLIGHT BOTTOM UNEVENNESS**

Moscow PRIKLAADNAYA MATEMATIKA I MEKhanika in Russian Vol 43, No 4, Jul/Aug 79 pp 639-646 manuscript received 24 Feb 78

DOTSENKO, S. F. and CHERKESOV, L. V., Sevastopol'

[Abstract] Two-dimensional and three-dimensional problems of diffraction of a plane gravity wave on unevenness of the bottom of a basin of arbitrary shape are considered within the framework of the general nonlinear theory of irrotational waves in a liquid of finite depth. It is assumed that the height of the bottom unevenness is small compared with the mean depth of the basin. This yields asymptotic expressions for the scattered waves, enabling analysis for a wide class of forms of bottom unevennesses. It is shown that the incident gravity wave generates a field of scattered

surface waves that includes a reflected and passing wave that have amplitudes of the order of  $\xi = h_0/H_0$ , where  $h_0$  is the maximum value of the parameter characterizing the bottom unevenness, as well as a system of waves that is localized in the vicinity of the bottom unevenness, and has an amplitude that decreases exponentially with increasing horizontal distance in the direction of wave propagation. Bottom unevenness with height dependent on distance in the direction of wave propagation has waveguide properties. The limits of applicability of the proposed approximation are considered. Figures 4, references 11: 8 Russian, 3 Western. [401-6610]

USSR

UDC 539.3

**SURFACE WAVE PROPAGATION IN A STOCHASTIC NONHOMOGENEOUS ELASTIC LAYER  
(MARKOV APPROXIMATION)**

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 43, No 4,  
Jul/Aug 79 pp 746-752 manuscript received 20 Mar 78

BESTUZHEVA, N. P. and CHIGAREV, A. V., Voronezh

[Abstract] An analysis is made of the behavior of an unsteady surface wave in a linearly deformable isotropic inhomogeneous medium with elastic moduli that are random functions of the coordinates. It is assumed that the medium is bounded by an arbitrary, relatively smooth curve. The analysis of the surface wave fronts is based on geometric optics concepts of the wave as a line of discontinuity of the derivatives of displacements that propagates along the bounding surface. Dynamic, kinematic and geometric conditions of compatibility are used with methods of discontinuous solutions to reduce a system of partial differential equations to an ordinary differential equation relative to the intensity of a wave whose velocity at each point of the inhomogeneous surface coincides with the Rayleigh velocity. This equation is supplemented by a system of relations that characterize the change in geometric parameters of the surface front during propagation. An examination is made of specific models of stochastic media for which the investigated processes are Markovian and are described by methods of the theory of multidimensional random Markov processes. Conditions are established relative to the nature of distribution of the surface inhomogeneity allowing application of the Markov approximation. References 12: 10 Russian, 2 Western. [401-6610]

USSR

UDC 621.165.533.6

# ANALYSIS OF BOUNDARY LAYER CHARACTERISTICS WITH ALLOWANCE FOR EXTERNAL FLOW TURBULANCE

Moscow TEPLOENERGETIKA in Russian No 9, 1979 pp 43-45

SHERSTYUK, A. N. and SUL'GINA, T. V., Moscow Institute of Chemical Machine Building

[Abstract] A semiempirical method for the analysis of boundary layer characteristics in divergent channels with allowance for the effect of flow turbulence outside the boundary layer is proposed. It is shown that an increase in the degree of external-flow turbulence  $\xi$  results in an increase in boundary-layer turbulence, an attendant decrease in the critical Reynolds number  $Re_{cr}$ , and an increase in the Prandtl constant. The corresponding frictional coefficient is derived by the method of successive approximations and found to increase with increase in  $\xi$ . These findings are in agreement with experimental findings, and are of interest considering that in multistage turbines, pumps, and compressors, the turbulence of external flow may reach 10-20% which markedly affects blading performance. Figures 5; references 19: 16 Russian 3 Western. [449-1386]

USSR

UDC 621.165.53.093

# NUMERICAL INVESTIGATION OF SUBSONIC, TRANSONIC, AND SUPERSONIC DISCONTINUOUS FLOW OF SPONTANEOUSLY CONDENSING AND WET STEAM IN TURBINE CASCADES

Moscow TEPLOENERGETIKA in Russian No 9, 1979 pp 62-65

FILIPPOV, G. A., SALTANOV, G. A. and SIMANOVSKIY, G. P., VNIIAM

[Abstract] The problem of mixed (sub-, tran-, and supersonic) flow of condensing steam in a flat cascade of blades is considered with respect to a model of two-dimensional flow of supersaturated and two-phase medium. It is assumed that the condensed phase forms as a result of spontaneous homogeneous condensation of supersaturated steam. Flow types with either condensation or evaporation of droplets are considered, i. e. a temperature imbalance is present. The flow is externally adiabatic, i. e. there is no admission of heat across the boundary of the investigated region. The corresponding system of equations of conservation of the medium is integrated. A procedure for partitioning the analyzed domain by means of a difference grid is proposed. It is shown that the wetness of steam varies over the blade cascade as a function of the pressure drop and initial superheat. The findings apply to inviscid laminar flow; in real flow the condensation processes may be affected by such factors as increased

flow turbulence, the formation of wake eddies, periodic instability, etc. An approximate method for taking flow vorticity into account is possible. Under specified conditions the flow of supercooled steam across the cascade may alternate with the flow of wet steam. Figures 6; references 12: 11 Russian, 1 Western.  
[449-1386]

USSR

UDC 586.33

RADIANT ENERGY TRANSFER IN A HYDROGEN PLASMA LAYER (2. INVESTIGATION OF FLAT AND CYLINDRICAL PLASMA LAYERS WITH PREDETERMINED TEMPERATURE DISTRIBUTION)

Vil'nyus TRUDY AKADEMII NAUK LITOVSKOY SSR. SERIYA B, KHIMIYA, TEKHNIKA, FIZICHESKAYA GEOGRAFIYA in Russian No 4(113), 1979 pp 75-84 manuscript received 10 Feb 78

SHIDLAUSKAS, V. A. and TAMONIS, M. M., Institute of Physicotechnical Problems of Power Engineering Academy of Sciences, Lithuanian SSR

[Abstract] The preceding article of this series gave the results of a study of the total and spectral radiation of a hemispherical layer of hydrogen plasma, and showed the necessity for a detailed consideration of basic radiation processes. The conditions of radiation in real plasma devices are much different from those in a hemispherical layer. In this paper, a technique is worked out for numerical calculation of the radiation flux in plane and cylindrical layers of radiating gas with detailed consideration of optical spectral properties. Numerical calculations show that radiation in isothermal plane and cylindrical layers of hydrogen plasma at identical values of  $L \times p$  (where  $L$  is the distance between parallel plates and  $p$  is pressure) is determined to a considerable extent by the flow temperature, and because of this, the data obtained for a gray gas should not be used. It is shown that the nonisothermicity of a hydrogen plasma flow shows up most strongly at smaller optical thicknesses of the medium, and depends on the location of high-temperature zones; in this connection, the average mass temperature of the flow should not be used in calculating plasma radiation. Extremum values of radiation heat flux are found by numerical calculations for nonisothermal hydrogen plasma layers with temperature distribution according to the equation

$$T = T_w + A \cdot \cos\left(\frac{\pi y}{2}\right) + (T_f - T_w - A) \cdot \cos^2\left(\frac{\pi y}{2}\right),$$

where

$$A = \frac{T_f + T_w - T_m}{4}$$

Here  $T_w$  is the wall temperature,  $T_f$  is the flow temperature and  $T_m$  is the average mass temperature of the flow. Figures 6, references 10: 4 Russian, 6 Western.  
[407-6610]

HYDRODYNAMIC CHARACTERISTICS OF A BUNDLE OF SMOOTH TUBES IN A TRANSVERSE FLOW OF AVIATION OIL IN THE PROCESS OF HEAT EXCHANGE AT LOW REYNOLDS NUMBERS

Vil'nyus TRUDY AKADEMII NAUK LITOVSKOY SSSR. SERIYA B, KHIMIYA, TEKHNIKA, FIZICHESKAYA GEOGRAFIYA in Russian No 4(113), 1979 pp 85-93 manuscript received 5 Apr 78

BUBYALIS, E. S., ULINSKAS, R. V. and ZHUKAUSKAS, A. A., Institute of Physicotechnical Problems of Power Engineering, Academy of Sciences Lithuanian SSR

[Abstract] A study is done on laminarized flow of aviation oil transversely through a checkered tube array with relative pitch  $a \times b = 1.25 \times 1.25$  at a Prandtl number of 2068 and Reynolds number of 1448. The velocity distribution is measured in an isothermal flow, and temperature profiles are measured with heating of the calorimetric tube under conditions where the heat flux at the wall is constant. A diagram is given for the flow pattern around the first tube row, plotted on the basis of measurements, photographs and visual observations in the investigation of hydrodynamic characteristics of heat exchange. It is found that with a transition from a negative to a positive pressure gradient there is a considerable change in the shape of the velocity profile across the boundary layer: the maximum value of perturbations generated in the accelerating flow is observed at  $n \approx 0.1$ , where  $n$  is the ratio between the coordinate perpendicular to the direction of flow and the thickness of the hydrodynamic boundary layer, whereas this maximum is observed at  $n \approx 0.375$  in a decelerated flow. Laminar flow separation from a tube in the bundle is observed at slight positive pressure gradients. The point of flow separation shifts from  $\phi = 170^\circ$  to  $95^\circ$  with a transition from a Reynolds number of 100 to  $Re = 1500$ , where  $\phi$  is the angle reckoned from the frontal critical point of the tube. In laminar flow of high-viscosity liquids around tube bundles, it is advisable to enhance artificial roughness to intensify heat exchange near the surface. Figures 10, references 3: 1 Russian, 2 Western. [407-6610]

## VIBRATION OF CURVED TUBES IN A BUNDLE IN A TRANSVERSE WATER FLOW

Vil'nyus TRUDY AKADEMII NAUK LITOVSKOY SSSR. SEIYA B, KHIMIYA, TEKHNIKA, FIZICHESKAYA GEOGRAFIYA in Russian No 4(113), 1979 pp 95-105 manuscript received 12 Apr 78

KATINAS, V. I., SHUKSTERIS, V. S. and MIKISHEV, A. N., Institute of Physicotechnical Problems of Power Engineering, Academy of Sciences, Lithuanian SSR

[Abstract] The problem of vibration control is considered in the case of pipes of a heat exchanger in a transverse flow. Experiments are done on a model of a section of a tube bundle of an actual heat exchanger made up of bent tubes with diameter of 8 mm in a transverse flow of water. The fastening in the tube plate is done by seven different methods. It is found that the principal factors that excite vibrations are the turbulent pulsations of flow pressure that arise as the coolant flows around the tubes, and also hydroelastic interaction between the flow and a tube. It is found that a tube bundle of the "spider" type can operate without appreciable vibrations only at  $Q/Q_{\max} = 0.4$ , where  $Q$  is the flowrate of the coolant passing through the experimental section in  $\text{m}^3/\text{hr}$ , and  $Q_{\max}$  is the design flowrate of the coolant ( $3600 \text{ m}^3/\text{hr}$ ). Figures 8, references 9: 5 Russian, 4 Western.  
[407-6610]



USSR

UDC 531.8

INTERMITTENT WALK OF A (LEGGED) ANTHROPOMORPHIC MECHANISM: I. SINGLE FULCRUM STAGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, 1979 pp 24-33 manuscript received 27 Apr 78

VELERSHTEYN, R. A. and FORMAL'SKIY, A. M., Moscow

[Abstract] The problem of the synthesis of the movements of an anthropomorphic mechanism moving (nearly) by inertia, i.e. accomplishing ballistic motions, is considered for a mechanism consisting of seven members--a body and two identical three-member legs consisting of a thigh, a shin, and a foot each. As in the process of human walk, a distinction is made between two stages--the double fulcrum stage, and the single fulcrum stage during which the body balances itself on a single foot. The "joining" of ballistic motions requires sudden changes in speed, that is, pulsed movements of the joints. The pertinent boundary-value problem in the case of a nonlinear system is solved by means of an iterative process. Numerical investigation shows that for a nonlinear system, by contrast with linear systems, the boundary-value problem has several different solutions. It is established that the attendant symmetry of configuration of the biped mechanism before and after each step it takes is such that its ambulatory motion cannot be humanoid. Figures 8, references 19: 18 Russian, 1 Western.  
[487-1386]

USSR

UDC 531.8

CONTROL OF THE MOVEMENT OF THE ANTHROPOMORPHIC LEG DURING THE STEP STAGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, 1979 pp 34-40 manuscript received 8 Jun 78

VASENIN, V. A., Moscow

[Abstract] The various possible ways of organizing movements of the leg in the step phase, serving to produce a near-anthropomorphic gait, are explored for a leg represented by a doubly articulated pendulum and consisting of a thigh and a shin, both with the same mass distribution. The problem is investigated on the basis of an approximation of momentum-shock controls. Analysis of the set of controlled movements of the systems resulted in isolating the movements and the corresponding controls satisfying the conditions of naturalness of gait, as based on biomechanical research into human gait. Thus the proposed model of the anthropometric leg in the step stage satisfactorily reproduces the kinematic characteristics



of the movements of the human leg. This warrants assuming that, by analogy with the model, the forces of viscous friction or other forces of an analogous nature also are a major factor in controlling leg movements during the execution of a step. This feature should be taken into account when designing anthropomorphic walking mechanisms and their control systems. Figures 5; references 8: 5 Russian, 3 Western.  
[487-1386]

USSR

UDC 531.8

#### SHOCK EFFECTS IN BIPED GAIT CONTROL PROBLEMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian  
No 5, 1979 pp 41-47 manuscript received 30 Oct 78

LAVROVSKIY, E. K., Moscow

[Abstract] The problem of plotting the gait of a biped walking apparatus is examined. The solution is constructed on the basis of theorems of the motion of the center of mass of the system and the "comfortability" principle of the movement of various points of the body at low accelerations, primarily owing to considerations of normal functioning of the interior instrumentation. Numerical investigation of energy characteristics shows that they sharply decrease with decrease in the height  $h$  of the body above ground. Thus, for low-slung bodies with  $h = 0.5$  m the dynamic characteristics of gait sharply increase. This effect is termed the shock effect since it is accompanied by, in particular, a drastic increase in the forces of reaction to the steps alternately executed by the two legs of the body. The shock effect is a consequence of the hypotheses adopted in constructing the solutions, and primarily of the hypothesis of comfortability of motion and of the absence of feet on the legs of the machine. It appears that the abandonment of either of these hypotheses should assure a shock-free gait. Figures 8; references 6: 4 Russian, 2 Western.  
[487-1386]

## IMITATION OF GAIT IN THE PRESENCE OF WEIGHTLESSNESS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian  
No 5, 1979 pp 48-53 manuscript received 20 Apr 78

BELETSKIY, V. V. and KONIKOVA, I. S., Moscow

[Abstract] The imitative anthropomorphic walk of a biped apparatus in the presence of weightlessness is examined from the standpoint of theorems of motion of the center of mass of the apparatus. The findings are used to demonstrate that during walking on a surface the control actions in the joints are indeed largely geared to overcoming the effect of gravity and only to a much smaller degree geared to overcoming the inertia of the limbs. The problem is of importance in itself as well, as a model of the possible movements of an astronaut in the absence of gravity. Within the framework of the plane model of dynamics it is shown that the imitation of gait in the presence of weightlessness indeed requires comparatively small control movements, only a fraction as large as those required for walking on a surface in the presence of gravity. Leg movements are specified and the controls in the joints as well as the periodic compensating oscillations of the body are determined. An integral of the moment of momentum exists in the problem considered. The determination of the periodic movement of the body reduces to finding the corresponding constant of that integral. Figures 5; references 3 Russian.  
[487-1386]

## VIBRATIONAL TRAVEL DOWN A PULSATING INCLINED PLANE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian  
No 5, 1979 pp 54-64 manuscript received 21 Dec 78

ANDROPOV, V. V., Moscow

[Abstract] The relative movement of a material particle down an inclined plane surface subjected to the action of periodic instantaneous pulsations is considered. These pulsations act at right angles to the line of steepest descent. In the intervals between the pulsations the translational movement of the particles is rectilinear and uniform. The magnitude and direction of the relative mean particle velocity are determined. The associated problem of vibrational travel along a harmonically oscillating plane surface bearing rectilinear limiters (baffles) in the path of its steepest descent is examined. It turns out that in this case, with collisions between the particles and the baffles (vibroshock movements),

the achievable rates of transport can be much greater than in the presence of purely vibrational motions. This effect is associated with the fact that vibroshock systems display stable oscillations with much greater amplitudes than do the corresponding shock-free systems. Figures 5: references 8 Russian.  
[487-1386]

USSR

UDC 531.8

#### OSCILLATIONS OF A ROTATING DEFORMABLE DISK

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian  
No 5, 1979 pp 65-71 manuscript received 6 Mar 78

OCHAN, M. YU., Moscow

[Abstract] Wire-wound or organic filament-wound laminated rotors are becoming used increasingly widely to enhance rotor strength and safety. It can thus be assumed in rotor research that a rotor consists of closed concentric thin rings, successively wound, and have an annular clearance filled with a binder. In the presence of an imbalance the rings may get displaced in a radial direction, i.e. lie eccentrically relative to the shaft. If this displacement is substantial, the rotor may break owing to either considerable loads on the shaft or rupture of the binder between the filaments. In such rotors, as in rotors with a flexible shaft, resonance may take place, i.e. there may occur a mode in which deformations and displacements of the loops become infinite even when the imbalance is small. By contrast with the case of the flexible shaft, in this case the elastic element is the rotor body itself. It is shown that the attendant problem of finding the critical angular velocity of the rotor reduces to an eigenvalue problem. A transcendental equation for finding the minimum eigenvalue, at which resonance occurs, is presented. Figure 1; references 4: 3 Russian, 1 Western.  
[487-1386]

## THE PRINCIPLE OF SEQUENTIAL CONTINUITY AND THE PROBLEM OF THE CONTACT OF COAXIAL CYLINDERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian  
No 5, 1979 pp 72-81 manuscript received 3 Nov 78

POGODIN, V. K. and TSVIK, L. B., Irkutsk

[Abstract] The axisymmetric problem of connecting two coaxial cylinders is considered from the standpoint of reducing the conjugation of solutions in a system of contacting solids to a sequence of boundary-value problems for discrete contacting subregions. Given a universal computer program assuring a numerical solution of the problem with respect to discrete bodies, such an approach contributes to standardizing the algorithms for computing the state of the composite body design by eliminating the stage of the construction and solution of the equations ensuing from the conditions of contact between subregions and hence also reducing the required computer memory volume. The solution process is constructed on utilizing the errors in the matching of stresses and displacements at the contact surface. The static and kinematic conditions of the coupling are successively satisfied in the course of the iterations. Analysis of the ratio between the integral rigidity characteristics of the coupled bodies serves to substantiate the convergence of the proposed process and to estimate the rate of that convergence. The investigation was performed with respect to bodies in complete contact, but the solution of unilateral contact problem is also found to satisfy a variational minimum principle, and hence the findings can be extended to apply to the solution of unilateral contact problems. Given the satisfaction of the conditions of the existence and uniqueness of the problems in question, the constructed approximations converge toward the true solution of the problem when the errors in matching tend toward zero. Figures 6; references 10: 8 Russian, 2 Western.  
[487-1386]

## CALCULATION OF FREE OSCILLATIONS OF A SHELL OF NEGATIVE CURVATURE USED AS THE FLEXIBLE ELEMENT IN STRAIN-WAVE GEARING

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian  
No 5, Sep/Oct 79 pp 144-149 manuscript received 17 Jan 79

NEDESHEV, YU. B., Moscow

[Abstract] Traveling waves are generated in a shell in the operation of strain-wave gearing, where flexible elements having the form of a shell of negative curvature are increasingly being used as the flexible component.

Such elements have greater compliance for the spreading action of the wave generator than cylindrical and conical shells. Hinged shells of negative curvature have certain dimensions where they become more flexible. These are called the natural dimensions, and shells of such sizes are preferable for strain-wave gearing. In this paper, an asymptotic recurrent process is proposed for determining the lower frequencies and modes of oscillations of a hinged shell of revolution of negative Gaussian curvature with natural dimensions. The solution is found on the basis of complete moment equations of the theory of shells by expanding the unknown quantities in asymptotic sums with respect to a small parameter that characterizes the relative half-thickness of the shell. A numerical example is given. Figure 1, references 5 Russian. [487-6610]

USSR

UDC 624.07:534.1

#### OPTIMIZATION OF THE NATURAL OSCILLATION FREQUENCIES OF CURVILINEAR THIN ELASTIC RODS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, 1979 pp 162-168 manuscript received 9 Jun 78

SMIRNOV, A. B. and TROITSKIY, V. A., Leningrad

[Abstract] The problem of optimizing the natural oscillation frequencies of curvilinear thin elastic rods, stated in the form of an isoperimetric variational problem, is solved. An isoperimetric condition is formulated and the piecewise-continuous function satisfying that condition is derived. The rod axis is assumed to be inextensible and a moving coordinate system is employed. It is further assumed that the square of any natural oscillation frequency equals the ratio between amplitudes of the potential and kinetic energies. It is shown that the problem can also be solved numerically by the gradient method. For both planar and nonplanar oscillation frequencies of the rod the optimal rod profile is found to be continuous. Figures 2; references 12: 10 Russian, 2 Western. [487-1386]

## SELF-RESONANT EXCITATION OF HIGHER-ORDER VIBRATION MODES IN MECHANICAL OBJECTS

Moscow MASHINOVEDENIYE in Russian No 6, Nov-Dec 79 pp 3-11 manuscript received 5 Jul 78

GERTS, M. YE., Moscow

[Abstract] Excitation of higher-order vibration modes in instruments which measure mechanical quantities by the frequency method is an expedient way to reduce the length and improve the precision of vibration tests. Here the feasibility of self-resonant excitation and feedback stabilization of higher-order modes is considered in linear objects with drifting parameters. The complete system includes, in addition to the object, a vibrator and a feedback transducer consisting of a nonlinear element in series with a linear one. Its performance is calculated from the equation of motion, with a subsequent dynamic analysis on a hodograph and in the phase plane. Taken into consideration are the transducer characteristics, usually of the relay or saturation kind. Excitation of desirable modes by appropriate positioning of both vibrator and transducer is demonstrated in the case of an object with three degrees of freedom. On the basis of these general results and for illustration, a multidimensional feedback structure is synthesized with a relay characteristic and an ideal phase shifter which will excite a 4-mass object with stiffness and damping to self-resonance in every mode. Figures 5; tables 1; references 11: 10 Russian, 1 Western.  
[489-2415]

## KHALIL AKHMEDOVICH RAKHMATULIN CELEBRATES HIS SEVENTIETH BIRTHDAY

Moscow PRIKLADNAYA MATEMATIKA I MEKhanika in Russian Vol 43 No 4, Jul/Aug 79 pp 579-582

[Abstract] Khalil Akhmedovich Rakhmatulin was 70 years old on 23 April 1979. Professor Rakhmatulin is chairman of the department of gas and wave dynamics of the college of mathematical mechanics at Moscow State University. He holds the degree of doctor of physical and mathematical sciences and is an academician of the Uzbek Academy of Sciences. Rakhmatulin's contributions to science have been in the areas of wave propagation in elastic and plastic media, motion of multiphase and multi-component media, soil dynamics, aerogas dynamics, chemical technology and others. He was awarded the Lomonosov Prize in 1945 and the State



Prize of the USSR in 1949 for research on the dynamics of elastoplastic waves. He is one of the founders of the theory of interpenetrating motion of multiphase media (1956). In the last decade he has done developmental work on aerochemical mechanics, which has been instrumental in the area of cotton cellulose production and cleaning of rice grains and cotton seed. Rakhmatulin has written more than 200 works, including 8 books. His monograph "Prochnost' pri impul'snykh kratkovremennyykh nagruzkakh" [Strength Under Momentary Impact Loading] has gained worldwide recognition.  
[401-6610]

USSR

UDC 531.8

#### ON THE PROBLEM OF STANDING OF A LEGGED VEHICLE

Moscow PRIKLADNAYA MATEMATIKA I MAKHANIKA in Russian Vol 43, No 4, Jul/Aug 79 pp 591-601 manuscript received 3 May 78

BELETSKIY, V. V. and LAVROVSKIY, E. K., Moscow

[Abstract] An examination is made of the motion of a legged vehicle when one leg is off the ground. A heavy body is considered with two multi-jointed legs fastened to one point. The legs are taken as weightless and inertialess with joints that have three degrees of freedom. It is assumed that the support point of the standing leg and the point of joining to the hull of the vehicle are fixed in space. The equations of motion of the hull are derived and studied for the limiting case of walking where the length of a stride and the speed of walking approach zero. The investigated motions can be taken as generative for movements during walking, and are also of independent interest for analyzing the conditions of standing. Figures 6, references 3 Russian.  
[401-6610]

USSR

UDC 539.3:534.1

#### STEADY-STATE VIBRATIONS OF AN ELLIPTICAL PLATE

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 43, No 4, Jul/Aug 79 pp 737-745 manuscript received 27 Dec 77

AKSENTYAN, O. K. and SELEZNEVA, T. N., Rostov-na-Donu

[Abstract] The authors consider forced steady-state oscillations of an isotropic homogeneous elliptical plate. The flat faces are taken as stress-free, and the load is assumed to be applied only to the lateral

cylindrical surface. An asymptotic method is proposed for finding the stressed and strain state of the plate for dynamic loading in the three-dimensional formulation. The analysis applies to the case of skew-symmetric (flexural) oscillations relative to the middle surface of the plate, although the method is applicable to symmetric oscillations as well. An example is given. Figures 5, references 7 Russian. [401-6610]

USSR

UDC 678.067.5

# THE EFFECTIVENESS OF RADIAL REINFORCEMENT OF THICK-WALLED SHELLS MADE OF COMPOSITES

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 15, No 8, Aug 79 pp 28-33  
manuscript received 10 May 78

TOMASHEVSKIY, V. T., ROMANOV, D. A., and SHALYGIN, V. N., Naval Academy, Leningrad

[Abstract] The effectiveness of two types of radial reinforcement of the edge zones of shells subject to internal and external loading is compared: the variants are uniform distribution of the reinforcing fibers and "programmed" distribution across the thickness of the shell. The volume percentage of short-fiber reinforcement material is less than 1%, and the thickness of the walls is up to half the size of the inside radius. The analysis is based on experimental linear regression equations for the radial modulus of elasticity, the modulus of elasticity under interlayer shear, the resistance to interlayer shear and the average ultimate compression strength as functions of the length and diameter of the reinforcing material and the volume percentage. For a given wall thickness, the optimal reinforcing scheme, which gives maximum strength with minimum content of reinforcing material, is determined by computer. It is found that a "programmed" distribution gives a considerably greater strength than uniform distribution, amounting to 27-32% for internal pressure and 40-44% for external pressure. Using "programmed" distribution, the percentage of radial reinforcing material can be decreased by roughly 50%. Figures 4, references 7 Russian.

**THE STABILITY OF VIBRATIONS OF A LIQUID-CONTAINING CYLINDRICAL SHELL IN NONLINEAR RESONANCE CONDITIONS**

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 15, No 8, Aug 79 pp 46-55  
manuscript received 16 Mar 78

PAVLOVSKIY, V. S. and FILIN, V. G., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The necessary and sufficient conditions for stability of stationary vibrational modes of a cylindrical shell partly filled with liquid during longitudinal excitation in the region of subharmonic and combined resonances are investigated. The bottom of the shell is assumed to be a circle of nondeformable material. The vibration is sinusoidal. Nonlinear equations of perturbed motion of the system are found by the Bubnov-Galerkin method accurate to quantities of the third order of smallness relative to the amplitudes of oscillations of the free surface of the liquid. It is found that nonlinear resonance states can arise at certain frequencies. The criteria of stable oscillations are related to the system parameters, resulting in indications of the manner in which they can be chosen so as to avoid resonance conditions. References 10: 7 Russian, 3 Western.

**CONTACT PROBLEM FOR A CYLINDRICAL SHELL AND A RIBBED CYLINDER UNDER AXIALLY SYMMETRIC LOADS**

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 15, No 8, Aug 79 pp 56-62  
manuscript received 20 Jan 77

FEDOROV, N. A., Kazan'

[Abstract] Previous works have considered the problem of interaction of a cylindrical shell with a thick-walled elastic cylinder under axially symmetric or arbitrary loads, including the variant in which the shell is fastened by a thin ring. The present work considers the special case of an orthotropic cylindrical shell to which an inner cylinder is fastened with longitudinal ribs on the inside. The materials of all components are linearly elastic. The shell may be reinforced by a thin circular ring. A variant of A. I. Lur'ye's elasticity equations is used for the shell. The solution takes the form of Fourier series for the peripheral coordinate, Fourier transforms for the axial coordinate, and Bessel functions for the radial coordinate. The result is a system of infinite equations

for determining the values of the forces of interaction between shell and cylinder, which may be truncated after a small number of terms. References 6 Russian.

USSR

UDC 539.3

#### ON A METHOD OF PARAMETRIC EXPANSION IN PROBLEMS OF BENDING OF FLEXIBLE PLATES AND SHELLS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15, No 8, Aug 79 pp 63-68  
manuscript received 15 Mar 78

KAYUK, YA. F. and ALEKSEYEVA, M. K., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A proof of the convergence of parametric expansions in problems of bending of flexible plates is given, and methods of analytical and numerical evaluation of the radius of convergence are suggested. A general scheme for proving convergence is demonstrated for a variety of operator equations and proven, and the method is applied to the specific case of large axially-symmetric bending of flexible circular plates with a free opening which are in equilibrium under an evenly distributed surface load. References 9 Russian.

USSR

UDC 536.12:62-503.55

#### OPTIMAL HEATING OF A PLATE WITH LIMITATIONS ON TEMPERATURE DIFFERENTIAL

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15, No 8, Aug 79 pp 69-73  
manuscript received 18 Jul 77

VIGAK, V. M. and KOSTENKO, A. V., L'vov Branch for Mathematical Physics, Institute of Mathematics, UkSSR Academy of Sciences

[Abstract] A problem of importance in the metallurgical industry and heat engineering is that of most rapid heating of a body with constraints on the maximum temperature of the heating medium or thermal flux and the temperature differential across the body. The authors consider optimum control of unsteady uniform temperature conditions of a plate, the constraints being maximum temperature of the heating medium and a maximum permissible temperature differential. There are two cases, in one of which the maximum possible temperature is the governing constraint, and in the other of which the maximum temperature differential is the determining factor. The differential equations for these two cases are solved, and a specific instance is solved and graphed. Figures 3, references 5: 4 Russian, 1 Western.

USSR

UDC 539.3.01

CONTACT INTERACTION OF A RECTANGULAR SLAB WITH ASYMMETRIC ROD REINFORCEMENT

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15, No 8, Aug 79 pp 74-79  
manuscript received 7 Jul 78

BABURCHENKOV, M. F., Kiev Institute of Civil Aviation Engineers

[Abstract] The problem of a rectangular slab reinforced by rods on opposite ends either in discrete fashion, periodically by sectors or continuously along its entire length, is solved by means of Fourier series. The rods are treated as elastic elements which are subjected to bending moments in the plane of maximum rigidity, as well as longitudinal forces. The problem entails solution of an infinite system of linear algebraic equations with coefficients that depend on the spacing of the rods. The values of the system coefficients are found for both discrete and continuous connection, and it is shown in the case of continuous connection that the infinite system is completely regular. Figures 5, references 7 Russian.

USSR

UDC 539.3

SPECTRAL CHARACTERISTICS IN PROBLEMS OF THE STABILITY OF CYLINDRICAL ORTHOTROPIC SHELLS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15, No 8, Aug 79 pp 106-110  
manuscript received 8 May 77

YERMOLENKO, V. M. and KORNEV, V. M., Institute of Hydrodynamics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] Starting from the equations for stability of a longitudinally compressed cylindrical shell, and making use of an approach suggested by R. Courant, an equation for the density of eigenvalues is obtained. The most important characteristics of the spectrum are the beginning point and the bunching point. These are determined from the orthotropic parameters. Graphs of calculated values for the beginning section of a spectrum in a specific instance are presented. Figures 3, references 8 Russian.

USSR

UDC 539.3

ON NUMERICAL SOLUTION OF THE PROBLEM OF BENDING OF ROUND PLATES OF VARIABLE THICKNESS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 15, No 8, Aug 79 pp 110-112  
manuscript received 27 Dec 78

AKHALAYA, T. G., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The deformation of flexible annular plates of variable thickness located in a geometrically nonlinear formulation is discussed. Nonlinear equations of the theory of thin shells based on the Kirchhoff-Love hypothesis are used as the starting point. A sequence of two-point linear boundary value problems is derived, each of which is solved by computer using a stable metrical method of discrete orthogonalization. Calculated results for four approximations are presented. Tables 2, references 5 Russian.

USSR

UDC 62-21:539.3

REDUCING THE MASS OF THIN SHELLS SUBJECT TO AXIAL COMPRESSION

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 79 pp 30-31

SIVAK, E. P., engineer

[Abstract] An experimental study of thin shells for structural and machine components subject to axial compression has established the feasibility of minimizing their mass by removal of rough surface layers, without appreciably changing the critical pressure. The twenty cylindrical shells for this study, with a radius of 75 mm and a total length of 255 mm, were made of 0.5 mm gauge AMg6M (aluminum-magnesium alloy) sheet by rolling and spot welding. Ten of them were tested in their initial condition with a 2.5  $\mu$ m surface roughness, ten others were first polished with paste and a felt wheel to various thicknesses smaller than 0.5 mm. Polishing was found to raise the average critical pressure from  $8.0 \cdot 10^2$  kgf/cm<sup>2</sup> only, with the test values becoming closer to theoretical ones. Table 1; references: 2 Russian.  
[469-2415]



USSR

UDC 620.179.14

**MAGNETOSTRICTION CONVERSION OF ACOUSTIC WAVES TO ELECTROMAGNETIC FIELDS ON DEFECTS OF MAGNETIZED SPECIMENS**

Sverdlovsk DEFECTOSKOPIYA in Russian No 5, May 79 pp 21-29 manuscript received 8 Feb 79

VLASOV, K. V., KAPLAN, M. D., MAYZENBERG, M. D. and BOBROV, V. T., All-Union Scientific Research Institute of Developing Nondestructive Methods and Instruments for Quality Control, Institute of Physics of Metals, Ural Science Center, Academy of Sciences USSR

[Abstract] A new magnetostriction method is proposed for inspection of magnetic materials. In contrast to the traditional electromagnetic-acoustic method, the proposed technique uses the electromagnetic fields that arise over a defect region as ultrasound propagates in a magnetized material. A qualitative theory is proposed for the formation of these fields, based on the assumption that the magnetic fields of the defects are considerably weaker than the constant magnetizing fields, while the ultrasonic wavelength is considerably greater than the characteristic dimensions of the defects. It is shown that the magnitude and distribution of the alternating field over the specimen is appreciably dependent on the shape and sizes of defects. A relationship is found between the electromagnetic field of a defect and the type of ultrasonic oscillations. Expressions are found that describe outside sources of electromagnetic fields for a number of types of ultrasonic waves most extensively used in flaw detection. The authors thank V. G. Vekhter, P. A. Khalilev and V. Ye. Shcherbinin for useful discussion of the work. References 25: 24 Russian, 1 Western.  
[408-6610]

USSR

UDC 620.179.16

**ULTRASONIC FIELDS OF SURFACE-EXCITED THICK PIEZOTRANSDUCERS**

Sverdlovsk DEFECTOSKOPIYA in Russian No 5, May 79 pp 80-87 manuscript received 4 Oct 78

KOROLEV, M. V., SHFVALDYKIN, V. G. and KARPEL'SON, A. YE., Scientific Research Institute of Internal Flaw Detection, Moscow

[Abstract] An experimental study is done on the ultrasonic fields set up by surface-excited thick piezotransducers [SETP]. The specimens were two-electrode and three-electrode structures with slotted and annular gaps between electrodes 0.2-0.4 mm wide. The transducers were cones or cylinders 5-18 mm high and 10-20 mm in diameter with coplanar electrodes

on the bases. The experiments were done in a water bath. The SETP to be studied was located at one end of the bath and was excited by electric pulses in the form of a single sine wave with frequency of 12 MHz. The recurrence rate of the pulses was 1 kHz and amplitude was 15-50 V. Coaxial with the SETP was a point reflector or a point received of ultrasonic signals. The output current from the receiver or from the SETP (when a reflector was used) was amplified, converted to voltage, and recorded by an oscilloscope. It is shown that the SETP has a wide band and is aperiodic, so that it is capable of producing pulses as short as tenths of a nano-second. In addition, such a device can produce ultrasonic fields of quite diverse modes. In particular, a device with two slot gaps can produce an ultrasonic beam that is uniform in one direction and weakly divergent in the perpendicular direction, while the SETP with annular gap produces an axially symmetric weakly divergent narrow ultrasonic beam. Figures 8, references 4 Russian.  
[408-6610]

USSR

UDC 620.179.16

#### CONCERNING POSSIBLE WAVEFORMS OF ACOUSTIC EMISSION

Sverdlovsk DEFECTOSKOPIYA in Russian No 5, May 79 pp 93-101 manuscript received 13 Nov 78

IVANOV, V. I., Central Scientific Research Institute of Technology and Machine Building

[Abstract] An examination is made of the formation of bursts of acoustic emission. The process of formation of an isolated burst is considered, assuming that loading of the solid is slow, i.e. the loading rate is much less than the speed of sound in the material. Slow quasistatic loading is typical of many cases where the method of acoustic emission is presently being successfully used. It is shown that elastic waves can be excited in this process only when the effective forces reach critical values where their sum is equal to the breaking strength of the atomic bonds of the material. The inhomogeneities that can act as sources of acoustic emission are all of the crystal lattice defect type. Some models of sources of acoustic emission are considered. An analysis is made of the case where a dislocation pileup breaks through a barrier. The equivalent electric circuit of a source of acoustic emission of relaxation type is considered. It is shown that the complete acoustic emission signal is a stochastic process that constitutes a sequence of relaxation and acceleration bursts. Figures 7, references 16: 12 Russian, 4 Western.  
[408-6610]

USSR

UDC 621.311.22.002.51:621.61-8-135.001.4

# TESTING OF BLOWER PIPES IN THE 800-MW POWER UNIT

Moscow ELEKTRICHESKIYE STANTSII in Russian No 7, Jul 79 pp 17-19

SANDZHIMITBIN, V. D., FLOS, S. L. and SILYUTINA, L. I., engineers, Donetsk Technical Administration for Power Engineering

[Abstract] The author's enterprise has tested the turbine drives of air blowers on the 800-MW power units of the Ugleborsk Regional Electric Powerplant. The experiments covered a broad range of operating speeds, from 3,000 to 6,000 rpm. A special series of experiments with the regulating valves fully opened was performed in order to determine the pressure losses in the regulating valves. The experiments determined that the drive turbines are quite economical. At about 5,000 rpm, the efficiency reaches 88%. The drive turbines support operation of the steam-generating apparatus with practically any condition of the gas-air line, with elevated turbine counterpressure. Figures 5.  
[474-6508]

USSR

UDC 621.165-33:531.424.001.4

# A METHOD OF TESTING OF THE SEAL OF THE STEAM DISTRIBUTION ELEMENTS OF STEAM TURBINES

Moscow ELEKTRICHESKIYE STANTSII in Russian No 7, Jul 79 pp 40-42

RYZHIKOV, V. K., engineer, FRAGIN, M. S., candidate of technical sciences, SHCHETININ, A. A. and GRUDOVSKIY, L. YE., engineers, Leningrad Metals Plant, Sevzapenergomontazh

[Abstract] A new test method was developed to estimate the degree of tightness of seal of steam distribution units in a turbine with significant deviation of the steam parameters from their nominal values. The method is based on the fact that a given flow rate of steam through the turbine corresponds to a definite rotating speed. Leakage of steam through valves is directly proportional to the steam pressure upstream from the valves. Therefore, the maximum permissible rotating speed, indicating sufficient seal of a valve, should depend unambiguously on the steam pressure before the valve. Comparison of tested rotating speeds with calculated speeds for a given steam pressure therefore provides a test of the tightness of seal of the valves. Figures 4, References 2 Russian.  
[474-6508]

USSR

UDC 621.313.1.027.81/88.048.019.34

## ELECTRIC STRENGTH OF INSULATION ON SUPERHIGH-VOLTAGE OVERHEAD TRANSMISSION LINES

Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 79 pp 31-33 manuscript received 22 Feb 79

DANIS, J., engineer, and KROMER, I. L., engineer, Hungarian People's Republic

[Abstract] Insulation for superhigh-voltage overhead transmission lines is selected on the basis of reliability during switching overvoltages and extreme changes in ambient conditions. A study of 400 kV and 750 kV insulator strings, porcelain and glass respectively, was made to determine their performance with dusty or moist surface under these severe conditions as expected in service. Four different configurations of a double string suspended from a cross beam 30 m above ground and at various horizontal distances from lateral poles were tested. The risetime of aperiodic voltage pulses was varied from 35  $\mu$ s (below critical) to 1200  $\mu$ s (above critical) and their duration was varied from 1000 to 10,500  $\mu$ s, the voltage level changed in 5% steps and successive pulses applied in 30-40 s intervals. The 50%-discharge voltage was estimated by the "up and down" method and the readings evaluated statistically by Student's method. The results yield the voltage-time characteristics of these insulator strings, with the dip of the 50%-discharge voltage down to its minimum critical level corresponding to an overvoltage pulse with the critical risetime. Further analysis yields also the risk and the number of flashovers, depending on the contamination distribution density, on the overvoltage amplitude distribution density, and on the number of weak spots. Contamination increases the probable number of flashovers during switching by 30-50%. Figures 3; table 1; references 2: 1 Russian, 1 Western. [466-2415]

USSR

UDC 621.762.5-982

## VACUUM SINTERING

Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 79 pp 36-39 manuscript received 13 Mar 79

MARMER, E. N., candidate of technical sciences

[Abstract] Vacuum sintering provides the best conditions for removal of volatile impurities from a material and, at the same time, minimizes its contamination with atmospheric nitrogen or oxygen. This process is applicable to such diverse metals as copper, titanium, niobium, tantalum,

chromium, molybdenum, tungsten, iron and nickel. Here it is examined from the standpoint of thermodynamic and kinetic interactions between metal and gases. The process time depends only on the temperature, the latent heat of evaporation and the diffusion activation energy. Some residual pressure must be allowed so as to prevent oxidation and excessive evaporation of the metal. Temperature remains the most critical parameter, inasmuch as it determines the rates of mass transfer and also the structural transformations. Accordingly, electric vacuum sintering furnaces are classified into: 1) low-temperature furnaces with heater elements made of high-resistance alloys, for sintering copper and iron, 2) medium-temperature furnaces with heater elements made of refractive metals or graphite, for sintering special alloy steels, 3) high-temperature furnaces with heater elements made of tungsten, graphite, or niobium carbide. All furnaces are lined with proper thermally insulating material, whether firebrick or the same material used for heater elements. Here the main design and performance characteristics of several furnace models in each group are given including also some economic data illustrating the advantages of vacuum sintering. Figures 2; tables 3; references 8: 7 Russian, 1 Western.  
[466-2415]

USSR

UDC 621.165.73

#### STUDY OF THE CAUSES FOR THERMAL BENDING OF A ONE PIECE FORGED ROTOR

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 79 pp 8-10

FARA. NOV, V. K., candidate of technical sciences and PLATKOVA, L. M., engineer

[Abstract] A study is made of the causes for development of permanent thermal bends in one piece forged rotors as they are heated. A rotor made from a vacuum ingot of acid type 25KH1M1FA open hearth steel, weighing 51 tons, was tested to determine the reasons for development of permanent bending after heating to the normal operating temperature of 550-560°C. The macrostructure, microstructure and chemical composition of the rotor were analyzed. The studies indicate that the reason for bending of the rotor is heterogeneity of the composition of the metal with respect to the axis of the forging, caused by displacement of the axis of the forging relative to the axis of the ingot during forging. The study therefore demonstrated the importance and necessity of thermal testing of rotors. Figures 6, References 4: 1 Russian, 3 Western.  
[476-6508]

USSR

UDC 621.224:621.791.92.001.5

CAVITATION AND HYDROABRASIVE RESISTANCE OF PARTS OF THE FLOW-CARRYING  
PORTION OF WATER TURBINES MADE OF STAINLESS STEEL

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 79 pp 19-21

TIMERBULATO, M. G., candidate of technical sciences and KRYANIN, I. R.,  
doctor of technical sciences

[Abstract] Results are presented from a study of the operating life of parts made of stainless steels. Parts tested included blades of type 20KH13NL steel, type OKH18N3GD2L austenitic-ferritic steel, type OKH12NDL steel and type 00KH12N3D, steel, a new type with good mechanical properties and cavitation resistance. Combined laboratory and field studies indicate that the new type of steel is effective for use in water turbine building and allows the quality and life of turbines to be increased. Photographs of cavitation wear and other damage are presented. Figures 3, References 7 Russian.  
[476-6508]

USSR

UDC 621.362+546.815.22+546.815.23+546.815.24

TEMPERATURE STABILITY OF THE SEMICONDUCTOR-EUTECTIC-METAL SWITCHING  
JUNCTION IN THERMOCOUPLE USING LEAD CHALCOGENIDES

Tashkent GELIOTEKHNIKA in Russian No 5, 1979 pp 30-33 manuscript received  
31 Mar 78

KAKHRAMANOV, K. SH. and ROSHAL', R. M., Special Design Office with Test Laboratory, Institute of Physics, Academy of Sciences of the Azerbaijan SSR

[Abstract] Inserting between the semiconductor and the metal wire of a thermocouple a switching interlayer of their eutectic alloy lengthens the life of contacts by preventing chemical reactions and also reduces thermal as well as electrical losses. Here the structural stability and strength of n-PbTe and NiSb as well as of their eutectic PbTe-NiSb alloy was studied over the 0-500°C temperature range, eutectic alloys being generally natural composite materials with a stronger interphase bond and more closely spaced particles of the dispersed phase than mechanical mixtures. According to the test results, the brittle-to-ductile transition in the eutectic alloy occurs already at temperatures within 100-150°C, only at temperatures within the 450-500°C range in n-PbTe and NiSb, and mechanical stresses during temperature cycling are thus about 25% lower than in PbTe and NiSb without such an interlayer. Figures 2; references 17: 15 Russian, 2 Western.  
[490-2415]



## FEATURES OF THE FILM MATERIALS TECHNOLOGY BY SOLAR FURNACES

Tashkent GELIOTEKHNIKA in Russian No 5, 1979 pp 43-47 manuscript received 4 Jun 78

FRANTSEVICH, I. N., DVERNYAKOV, V. S., KASICH-PILIPENKO, I. YE., TIKUSH, V. L., RUSAKOV, G. V., GAYEVSKAYA, L. A., SHAGINYAN, L. R. and BIRYUKOVA, R. S., "Order of Labor's Red Banner" Institute of Problems in Material Science

[Abstract] A feasibility study pertaining to production of thin films on semiconductor substrates by means of concentrated solar radiation was made using an SGU-5 furnace, a natural and pure high-temperature heating source. The device consists of a louver for regulating the density of incident radiant flux, a parabolic reflector, a quartz luminaire, and a water-cooled process chamber with the crucible movable into and out of focus for regulation. Thin films of aluminum, silicon and silicon oxide are thus deposited on substrate plates made of silicon single crystals with a class 14 surface finish, after thorough degreasing. Their thickness was measured and checked by microinterferometry. Subsequent electron diffraction, phase and microstructural analysis, by the reflection method, revealed films of condensate without any impurities. Figures 6; tables 2; references 8: 6 Russian, 2 Western.  
[490-2415]

## 'BLACK CHROME' ELECTROLYTIC COATINGS FOR SOLAR HEAT COLLECTORS

Tashkent GELIOTEKHNIKA in Russian No 5, 1979 pp 50-53 manuscript received 24 Jan 79

UMAROV, G. YA., GAZIYEV, U. KH., FAYZIYEV, SH. A., LI, V. V. and IRUKHOV, V. S., Physicotechnical Institute imeni S. V. Starodubtsev, Academy of Sciences of the Uzbek SSR

[Abstract] A study was made concerning the technology of "black chrome" electrolytic coatings with optical properties suitable for solar engineering ground equipment such as heat collectors. Coatings were deposited on collector steel with a copper or nickel underlayer from an electrolyte containing a fluorine salt as activator. Films of uniform thickness and with excellent optical properties, namely high solar absorptivity and low thermal emissivity, were obtained with an electrolytic solution containing 250-300 g/liter  $\text{CrO}_3$ , 0.2 g/liter  $\text{KF}$  or  $\text{NaF}$ , and 40-50 g/liter  $\text{Fe}_2(\text{C}_2\text{O}_4)_3$ .

5H<sub>2</sub>O or 2-4 g/liter NaNO<sub>3</sub> additive at a temperature of 15-17°C within 1.5-2 min with a current density of 50-120 mA/cm<sup>2</sup>. A surge of 200-250 mA/cm<sup>2</sup> for 30-45 s, furthermore, produced a substrate-film system with the most favorable reflection spectrum. These coatings were found to be both thermally and optically stable in a humid atmosphere as well as under vacuum. Figures 4; references 11: 4 Russian, 7 Western. [490-2415]

USSR

UDC 621.373.826:621.375.826:62-502.3

#### A HIGHLY STABILIZED SOURCE OF MEDIUM-POWER RADIATION

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 11, Nov 79 pp 33-36

YELISEYEV, P. G., YERMAKOVA, M. V., ZAGORSKIY, YA. T., STRAKHOV, V. P., STYSIN, V. YE., TIKHOMIROV, S. V., KHATYREV, N. P., KHLESKOVA, T. N. and YAKOVLEV, V. A.

[Abstract] A very stable source of medium-power monochromatic optical radiation is now available as a secondary reference measuring standard for medium-power state calibration standards. Since an individual determination of all causes of instability has not been feasible, its design is based on minimization of elimination by technological means of the composite of destabilizing factors. Both functionally and structurally it consists of a GaAs injection laser on a liquid-nitrogen cryostat, a stable pumping source with a set of ballast and measuring resistors, an optical system including a light conductor, an automatic power regulating system which includes a photoreceiver, a power density distribution recording instrument with a scanner, and a radiation simulator. It delivers a radiation power of 0.3-0.8 W, as a linear function of the injection current variable over the 1.5-3 A range, at the  $\lambda = 0.87 \mu\text{m}$  wavelength with a relative instability not exceeding 0.01%/h within the 0-1 Hz frequency band of fluctuation. Figures 2; references 6: 4 Russian, 2 Western. [497-2415]

USSR

UDC 621.384.63

#### GAMMA BREMSSTRAHLUNG FROM A THIN BETATRON TARGET

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 pp 40-44 manuscript received 8 Feb 78

GORYACHEV, B. I., KRYLOV, YE. S., SHEVCHENKO, O. P. and EKIVIN, V. V., Scientific Research Institute of Nuclear Physics, Moscow State University

[Abstract] The method of labeled photons is promising for the production of quasimonochromatic gamma quanta. By separating narrow energy intervals

from the bremsstrahlung spectrum, it is possible to produce intensive gamma quanta with a smooth change of energy and a line width of about 1%. It seems promising to use this method in standard nuclear spectroscopy instruments such as the betatron. When a nonmoving target is used, located near the equilibrium orbit, the task arises of combining the processes of acceleration and selection of electrons on the betatron target. This article is dedicated to achievement of this mode of acceleration. This mode of acceleration of electrons in the betatron may be interesting not only for construction of a gamma quantum monochromator, but also in experiments with photon bremsstrahlung when great increases in the length of a gamma ray burst generally involve losses of intensity. Figures 4, References 7: 4 Russian, 3 Western.  
[471-6508]

USSR

UDC 539.125.5

#### THERMOMAGNETIC ULTRACOLD NEUTRON EXTRACTORS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 49-51 manuscript received 27 Feb 78

NIKITENKO, YU. V. and TARAN, YU. V., Joint Institute of Nuclear Research, Dubna

[Abstract] Thermomagnetic ultracold neutron extractors can be quite useful in many cases when there is no need for high operating speed. If the thermomagnetic film in the extractor is made of a material for which  $\hbar^2 N_b / 2 T_m \ll B$ , the effective potential of interaction of the neutron with the film is determined primarily by its magnetic state. If the temperature is above the Curie point, the medium becomes paramagnetic, the potential is negligible and the film is practically transparent for ultracold neutrons. Below the Curie point, the film is in the thermomagnetic state and, if it is magnetized to saturation, ultracold neutrons will pass through it only with spin projections opposite to the direction of magnetization. This principle can be used to construct a thermomagnetic ultracold neutron extractor. Another type of thermomagnetic extractor is produced if the thermomagnetic film is made of a material for which  $\hbar^2 N_b / 2 T_m \gg B$ . For this type of extractor, the open state occurs when the temperature of the film is below the Curie point, the closed state--when it is above the Curie point. An ultracold neutron bottle equipped with this type of extractor does not require magnetization of the thermomagnetic film or concern with the maintenance of polarization of the neutrons, greatly simplifying the design of the extractor. Figure 1, References 3 Russian.  
[471-6508]

# A HIGH SPEED TRANSMISSION AVALANCHE COUNTER FOR RECORDING OF CHARGED PARTICLES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 pp 88-91  
manuscript received 21 Mar 78

NEUBERTH, A. and DUMBERS, F., Central Institute of Nuclear Research,  
East Germany Academy of Sciences, Dresden

[Abstract] The operation of avalanche counters is described. A photograph of an avalanche counter with an effective area of  $11 \text{ cm}^2$  is presented. A schematic diagram of the electronic circuit used to connect the avalanche counter into the measurement instruments is presented, as well as a graph of the variation in maximum amplitude of the electronic component of the voltage between the anode and cathode of an avalanche counter as shown in the photograph and a graph of the time resolution per counter as a function of operating voltage. Figures 4, References 4: 1 Russian, 3 Western.  
[471-6508]

# RECORDING OF PULSED RADIATION FROM SURFACE-BARRIER SEMICONDUCTOR DETECTORS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 91-95 manuscript received 20 Jan 78

GUROV, G. A., SAVEL'EVA, M. A. and TOCHILOVSKIY, G. P.

[Abstract] Some results are presented from studies of the properties of a semiconductor detector recording pulses of radiation. Studies are performed with a type DKPs gold-silicon surface-barrier semiconductor detector manufactured by "Izotop" Production Union. Radiation pulses were recorded using a system of measurement in which signals from the detectors were recorded on oscilloscopes and the signals were photographed. An electrostatic generator with a modulated beam was used as the source of pulses of alpha particles and protons. The experimental data indicate great capabilities for the detector for the recording of highly intensive beams of radiation in the current mode. The linear transformation of the energy of various types of sources to charge and the possibility of producing currents of several amperes are particularly important properties. Figures 7, References 6: 3 Russian, 3 Western.  
[471-6508]

## SURFACE-BARRIER Au(Si) DETECTORS IN GLASS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 96-97 manuscript received 3 Apr 78

TSEVTSOV, V. V. and KRAYUKHINA, V. V.

[Abstract] A group of 15 surface-barrier Au(Si) detectors in glass was manufactured with an area of sensitive surface of 10-25 mm<sup>2</sup> and an energy resolution of 20-35 keV at the 5486 keV line of <sup>241</sup>Am. The detectors were divided into 3 equal groups which were then tested for stability of electric parameters under normal conditions, in nitric acid and in organic solvent. The test results showed that the detectors can be used for alpha spectrometric measurements both under vacuum conditions and in the organic solvents tested, although in nitric acid with reverse bias, the gold coating on the sensing surface is dissolved. Figures 2, References 4 Russian.  
[471-6508]

## A SCANNING OPERATIONAL AMPLIFIER WITH A TUNABLE TRANSMISSION BAND

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 149-155 manuscript received 7 Mar 78

TSYTOVICH, L. I., Institute of Physics, Siberian Branch, USSR Academy of Sciences, Krasnoyarsk

[Abstract] A study is made of one version of construction of a scanning operational amplifier with an adjustable band of uniform transmission of frequencies, intended for use in adaptive systems of automatic control, testing and measurement, digital spectral analyzers and magnetic recording devices using discrete information carriers, and also for control of high-power pulse-duration converters. A structural diagram of the device is presented, as well as a schematic diagram of the electrical circuit. When operated in the forced oscillation mode, the device takes on the properties of a linear aperiodic first order link with a time constant proportional to the amplitude and period of the signal. One distinguishing feature of the device in comparison to ordinary filters is that it has no factor-divider devices in the direct transformation channel, allowing the additive error of the scanning amplifier to be limited to the level of drift parameters of the integrator. Figures 4, References 3 Russian.  
[471-6508]

USSR

UDC 621.317.77:621.396.666

# A PHASE-STABLE AMPLIFIER WITH AUTOMATIC GAIN CONTROL

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 153-155

FISHTEYN, A. F., Institute of Physics, Siberian Affiliate, USSR Academy of Sciences, Krasnoyarsk

[Abstract] An amplifier with AGC is described, in which high phase-amplitude stability is achieved by reducing current through the transistors and voltages across the transistors to quantities such that the transistors retain acceptable gain and frequency characteristics. A schematic diagram of the device is presented. Control of the transmission factor is achieved by changing the fraction of output current reaching the load. Equations are presented for estimation of the phase shifts caused by fluctuations in temperature in amplifiers of the type in question. Figure 1, References 7 Russian.  
[471-6508]

USSR

UDC 621.313.8

# FREE SUSPENSION OF MAGNETS IN A PERMANENT MAGNETIC FIELD WITH PYROLYTIC GRAPHITE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 238-240 manuscript received 24 Mar 78

PONIZOVSKIY, V. M., Perm' State University

[Abstract] Free stable suspension of a permanent magnet in the field of another magnet can be achieved either using electronic tracking circuits or diamagnetic substances. New magnets based on intermetallic compounds of rare earth elements, particularly magnets based on  $\text{SmCo}_5$ , and the use of pyrolytic graphite allow the creation of a free suspension system for rather heavy magnets. Possible free suspension systems are diagrammed, and a photograph of a suspended magnet in one type of system is presented. Optimal suspension parameters are calculated. The magnetic support systems suggested can be used in instruments in which the support of the sensing element does not require great lift, for example in sensitive accelerometers and speedometers, as well as in certain physical experiments. Figures 2, References 5: 3 Russian, 2 Western.  
[471-6508]



## PREPARATION OF 350NNI FERRITE FOR USE IN SUPERHIGH VACUUM SYSTEMS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
pp 267-268 manuscript received 4 Apr 78

VIZIR', V. A. and PASTUKHOV, YU. K., Scientific Research Institute of Nuclear Physics at Tomsk Polytechnical Institute

[Abstract] The authors tested domestic type 350NNI ferrite cores for use in high vacuum installations. The experimental cores were washed with acetone, dried and annealed in air at 500°C for two days. Two were then placed in a vacuum chamber, heated for one day at 300°C at a pressure of  $10^{-2}$  torr, then a type NORD-250 high vacuum pump was connected and the pressure was reduced to  $7 \cdot 10^{-9}$  torr in 24 hours. The coefficient of desorption measured by the difference in rates of pressure rise in the evacuated volume with and without the ferrite after the pump was shut off was  $2 \cdot 10^{-10}$  l·torr/cm<sup>2</sup>·s. This is two orders of magnitude lower than has been reported for nonannealed ferrite of the same type, but two orders of magnitude higher than for ecosorb ZN ferrite. It is expected that with longer annealing in a higher vacuum, desorption would decrease.

References 2: 1 Russian, 1 Western.

[471-6508]

## A HIGH SPEED AUTOMATED MEMORY OSCILLOSCOPE WITH A PROCESSOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79  
p 283 manuscript received 30 Jan 78

DENBNOVETSKIY, S. V., ORLOV, I. I., SHKURO, A. N., IVANUSHKINA, N. G., OVSYANNIKOVA, L. N. and KUTLIN, G. N.

[Abstract] The instrument described and illustrated is intended for recording and automation of processing of one-time and repeated pulsed signals in the microsecond and nanosecond range by calculation of their parameters and characteristics. The scale-time signal transformation method is used for a signal recorded on the target of a CRT with memory in real time and read off at a speed matched to the capacities of the analyzing and recording apparatus. The instrument consists of three sections with separate power supplies. The instrument can also be used as a basis for construction of multichannel information-computer systems controlled by a central specialized processor or computer. The transmission band is 0-50 MHz, the dynamic range of the input signal is 20 mV-20 V, the range of scan times is 100 ns-1 ms.

[471-6508]

USSR

UDC 535.8:535.214.4

#### A SMALL LOW FREQUENCY SECTION FOR A MODULATION RADIOMETER WITH REMOTE CONTROL PANEL

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul/Aug 79 p 284  
manuscript received 2 Feb 78

ZBOROVSKIY, V. S., SAMOYLOV, R. A., MOROZOVA, O. K., FEDYANTSEV, B. K.,  
and KHRULEV, V. V.

[Abstract] The device here described is intended for separation of a weak periodic signal from a background of noise in a radiometer. It consists of two electrically controlled attenuators, a low frequency amplifier, a synchronous detector and integrator, an IF amplifier, reference voltage generator and remote control panel. Connections are provided for strip-chart recorders and analog-code convertors. The voltage gain is 60 dB, input impedance 2.6 k $\Omega$ , output voltage 4 V, variation in gain 0-5 dB at intervals of 1 dB and 0-25 dB at intervals of 5 dB, modulation frequency 1 kHz. The time constant of integration is 1 or 16 s, power supply required +12 and -6 V.

[471-6508]

USSR

UDC 621.396.622

#### A BROAD-BAND TRANSISTOR MIXER

Moscow PRIBORY I TEKHNIKA EXPERIMENTA in Russian No 4, Jul/Aug 79 p 285  
manuscript received 30 Jan 78

MELIKHOV, S. V. and SHAYKIN, G. I.

[Abstract] The mixer is intended for shifting of the spectrum of signals to low intermediate frequency and can be used in panoramic devices, for the study of linear receiver sections, and also as an independent unit in broad band and narrow band receivers. The range of input frequencies is 0.08-1 GHz, IF 35 MHz, conversion factor 1 $\pm$ 0.5 dB, nonuniformity of afc  $\pm$ 1 dB, dynamic range for combined noise at least 20 dB at the optimal heterodyne power, at least 63 dB for adjacent noise with an output signal level at the IF of -85 dB/mW.

[471-6508]

USSR

UDC 621.643.072.001.5

# DETERMINATION OF THE RESISTANCE TO MOTION OF A ROLLER SUPPORTING A PIPE-LINE

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 79 p 18

KULYGIN, N. W., LUKSHA, V. O. and ANTIPOV, V. P., Northern branch, All-Union Scientific Research Institute of Trunk Pipelines Construction, Ukhta

[Abstract] An experimental segment of the surface gas pipeline in the Ukhta district is 1220 mm in diameter and supported on rollers. The resistance to transverse motion of these rollers was measured at a constant ambient temperature under perfect test conditions in reciprocal-motion bearings without misalignment, dirt, and flange rubbing. The measurements were made with a displacement transducer and a force transducer, both feeding signals to a recording instrument. At a roller velocity not exceeding 10 m/s under a vertical dead load of 27,300 kgf, the displacement was plotted as a function of the moving horizontal force at various instants of time. The maximum displacement recorded was 42 mm under a moving force of 150 kgf at the start. With the moving force then varying over the 134-158 kgf range, the average drag coefficient was found to be 0.0055 and thus on the low side of the 0.0045-0.0245 range established in previous studies. Figures 2; table 1.  
[470-2415]

USSR

UDC 621.643.001.24

# RELIABILITY OF THE PIPELINE OF A GAS SUPPLY SYSTEM

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 79 pp 19-21

SHADRIN, YE. YA., POPERECHNAYA, S. YE and SIBIRTSEVA, V. A., Tyumen' Scientific Research Institute and State All-Union Institute for Planning of Gas Supply Systems and Gas Industry Enterprises

[Abstract] A pipeline is the most vulnerable part of a gas supply system and continuous efficient service depends on its reliability. Here the probability of failures is calculated and, on this basis, the number of strands and their optimum diameters as well as the number of bypass connections are determined which will ensure that the reduction in gas volume due to failure does not exceed the difference between minimum production and guaranteed minimum delivery. Calculations are performed for a pipeline consisting of two or many strands of equal or different diameters, with valves along the line dividing it into  $n$  segments and bypassed on both sides. The results indicate that the pipeline reliability

depends on the number of strands and the number of segments, five strands being necessary and sufficient for satisfactory operation. As the number of strands increases, the probability of complete shutdown decreases and the probability of partial shutdown increases. The optimum length of a line segment is 20-40 km, depending on whether there are 2-4 or more strands. Existing pipelines ought to be modified accordingly. Figures 2; tables 2; reference 1 Russian.  
[470-2415]

USSR

UDC 621.311.25-621.039.002.56

DIRECT POTENTIOMETRIC MONITORING OF THE CHLORIDE ION CONTENT OF NUCLEAR REACTOR COOLING WATER

Moscow TEPLOENERGETIKA in Russian No 9, 1979 pp 36-40

MOSKVIN, L. N., VILKOV, N. YA., KRASNOPEROV, V. M. and YEPIMAKHOVA, L. V.

[Abstract] In view of the possibility of direct potentiometric determination of trace amounts of chloride ions in the cooling water of atomic power stations with the aid of the uniflow-type porous metal silver electrode (UPMSE), an optimal system of sensors has been developed along with pilot models of laboratory and automatic chloride meters. Comparison with other chloride measurement techniques such as sensors based on the Ag/AgCl electrode and the electroosmotic concentration technique indicated that, regardless of the technique used, the error of measurement in manual analysis amounts to several mg per liter owing to random contamination of samples during their collection and analysis. The UPMSE-based automatic-sensor chloride meter satisfy the requirements posed to methods and instruments for monitoring trace concentrations of chloride ions in the cooling water of nuclear reactors, and they not only reduce the labor requirement of such monitoring but also enhance the reliability of the data thus obtained. Figures 6; references 20: 16 Russian, 4 Western.  
[449-1386]

USSR

UDC 53.082.61.534.321

EXPERIMENTAL DETERMINATION OF THE SPEED OF ULTRASOUND IN WATER AT TEMPERATURES OF 266-423 K AND PRESSURES OF UP TO 100 ATM

Moscow TEPLOENERGETIKA in Russian No 9, 1979 pp 65-66

ALEKSANDROV, A. A. and KOCHETKOV, A. I., Moscow Energy Institute

[Abstract] The speed of ultrasound in water at temperatures of 266-423 K and pressures of up to 100 atm was measured by the frequency-pulse method

at frequencies of 2.5 and 6.5 MHz. The design of an experimental setup serving to reduce the measurement time of a given frequency from 10 to 0.1 sec is described. Two separate shielded leads are used to eliminate the effect of parasitic inductive and capacitive coupling. The experimental findings are tabulated. Comparison with the findings of other investigators show that the findings obtained in this study fit best a formula describing the speeds of sound with a standard deviation of 0.08 m/s. Figure 1; references 9: 1 Russian, 8 Western.  
[449-1386]

USSR

UDC 621.822.5.002.3:634.0.865:666.189.2

SLIDING BEARINGS MADE OF COMPOSITE MATERIALS ON A WOOD PULP AND GLASS FIBER BASE

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 10, Oct 79 pp 36-38

YEKIMENKO, N. A., candidate in technical sciences

[Abstract] A new composite molded material consisting of a wood pulp filler with 15-20% glass fiber reinforcement has been developed at the Institute of Mechanics of Metallopolymer Systems, Academy of Sciences of the Belorussian SSR, having a 3-4 times higher resilience than plain molded wood pulp. This material has been subsequently modified by the author to make it suitable also for machine components subject to friction, such as bearings and conveyer rollers. This requires impregnation of the base material with a polymer resin binder on one side and a lubricant such as graphite or fluorocarbon (Teflon) on the other side. It is possible to mold first, at a temperature within 145-155°C under a pressure of 100-150 kgf/cm<sup>2</sup>, and then impregnate with subsequent drying in air at 60-80°C, or to impregnate and mold together at a temperature within 155-165°C under a pressure of 350-450 kgf/cm<sup>2</sup>. The performance of bearings made of this material was tested in the laboratory. Impregnation was found to reduce the friction coefficient appreciably and to raise the load capacity up to 100 kgf/cm<sup>2</sup> over the 0.5-1 m/s range of sliding velocity. Figures 4; references: 2 Russian.  
[469-2415]

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